Instruments

THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

Including the

JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA

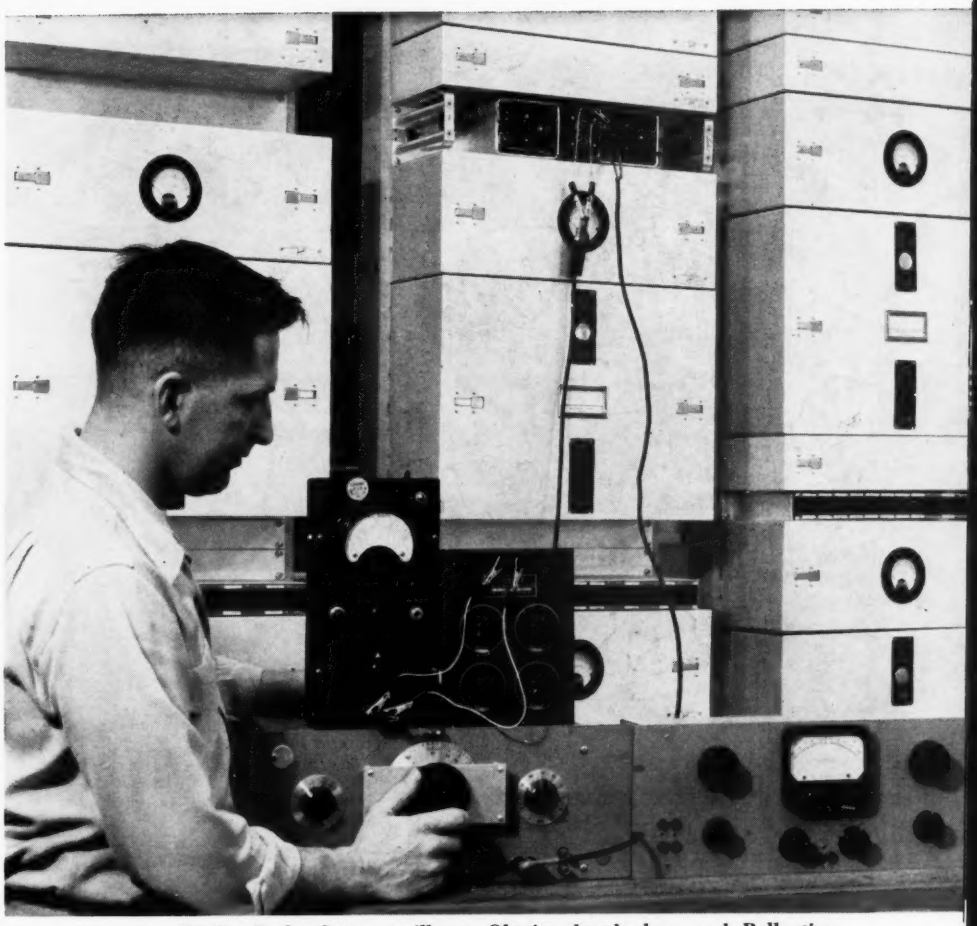
and the

JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION

In this issue . . .

Valve Rangeability
Fluid Flow through Control Valves
Multi-point Recording
Instrument Department Organization
Gas-pressure Regulation
Instrument Electronics
Maintenance of Pressure Recorders
Hydrostatic Test of Transmission Pipeline
ISA Exhibit Guide
ISA Tentative Technical Program
117 New Instruments
136 New Bulletins

Vol. 25 No. 8
AUGUST • 1952

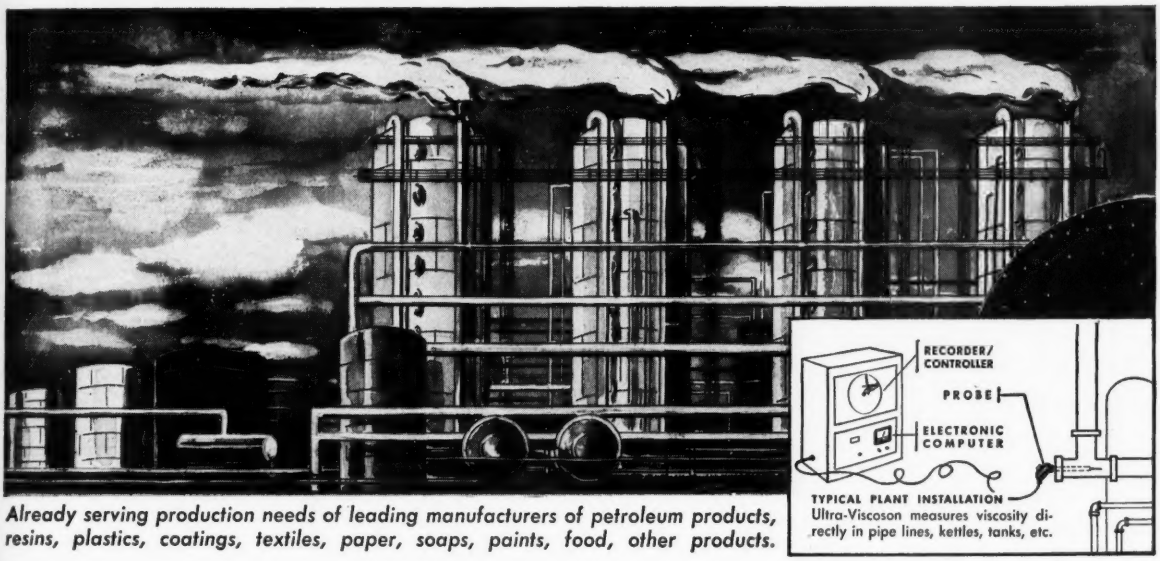


Hewlett-Packard test oscillator, Ohmite decade box, and Ballantine vacuum-tube voltmeter or transmission-measuring set are used to check Lenkurt filters. Story on page 954. *(Courtesy Lenkurt Electric Co.)*

Alrea
resins

PROBE INTO IT...

measure • record • control VISCOSITY *continuously*



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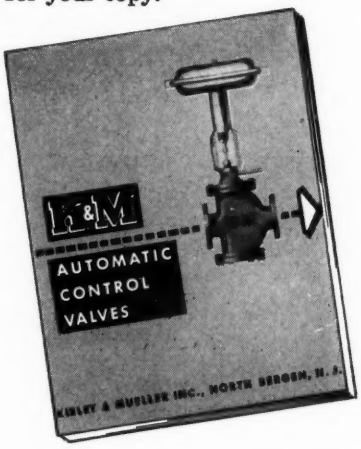

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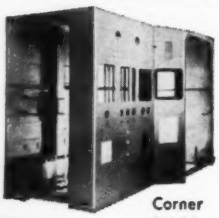
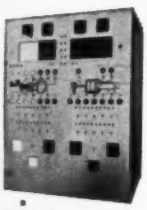


Corner Cubicle Section

Refinery Cubicle with Mimic Flow Diagram in Color



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Instruments

THE MAGAZINE OF MEASUREMENT INSPECTION · TESTING · CONTROL

Vol. 25 AUGUST 1952 No. 8

SPECIAL FEATURE

Seventh Annual Instrument Exhibit—Descriptive List and Personnel 1110

FEATURE ARTICLES

Valve Rangeability 1074
By Ralph A. Rockwell

Multi-point Recording 1080
By John G. Taylor

Principles of Fluid Flow through Control Valves 1082
By Dr. D. P. Eckman

Organization of Instrument Departments 1083
By Sherman S. Shaffer

Gas-pressure Regulation 1086
By W. L. Masheter

Maintenance of Pressure Recorders 1090
By R. Frank Fields

SERIAL

Instrument Electronics 1088
By Milton H. Aronson

THE MONTH'S NEW INSTRUMENTS 1022

INSTRUMENTS ON THE MARCH

Circuit Restorer—1150, New Instrumentation Magazine—1150, Direct Reading Spectrometer—1150, Infrared Spectrometer Application Service—1150, Priority M-71 Amended—1150, Radioactivity Survey Instrument—1152, Nucleonics Measures Fabric Coatings—1152, Analog Computer—1152, University of Tokyo Instrumentation Department—1154, Network Analyzer—1156, Instrument Lighting—1156, Light Probe—1156, Load Deflection Tests—1158, Beta-ray Gage 1158

MANUFACTURERS' NEW LITERATURE 1164

OTHER REGULAR FEATURES

Editorial Comment 1021
Instrumentation Events Calendar 1072
Advertisers' Index 1175

JOURNAL of the INSTRUMENT SOCIETY OF AMERICA 1091

Instrumentation for a Precision Creep-testing Laboratory 1096
By Joe Lundholm, Jr.

A Review of the Electric Displacement Gages Used In Railroad Car Testing 1101
By William Kneen

Tentative Technical Program—Seventh National Conference 1106

JOURNAL of the SOUTHERN CALIFORNIA METER ASSOCIATION

Hydrostatic Test of Transmission Line 1123
By W. L. Masheter

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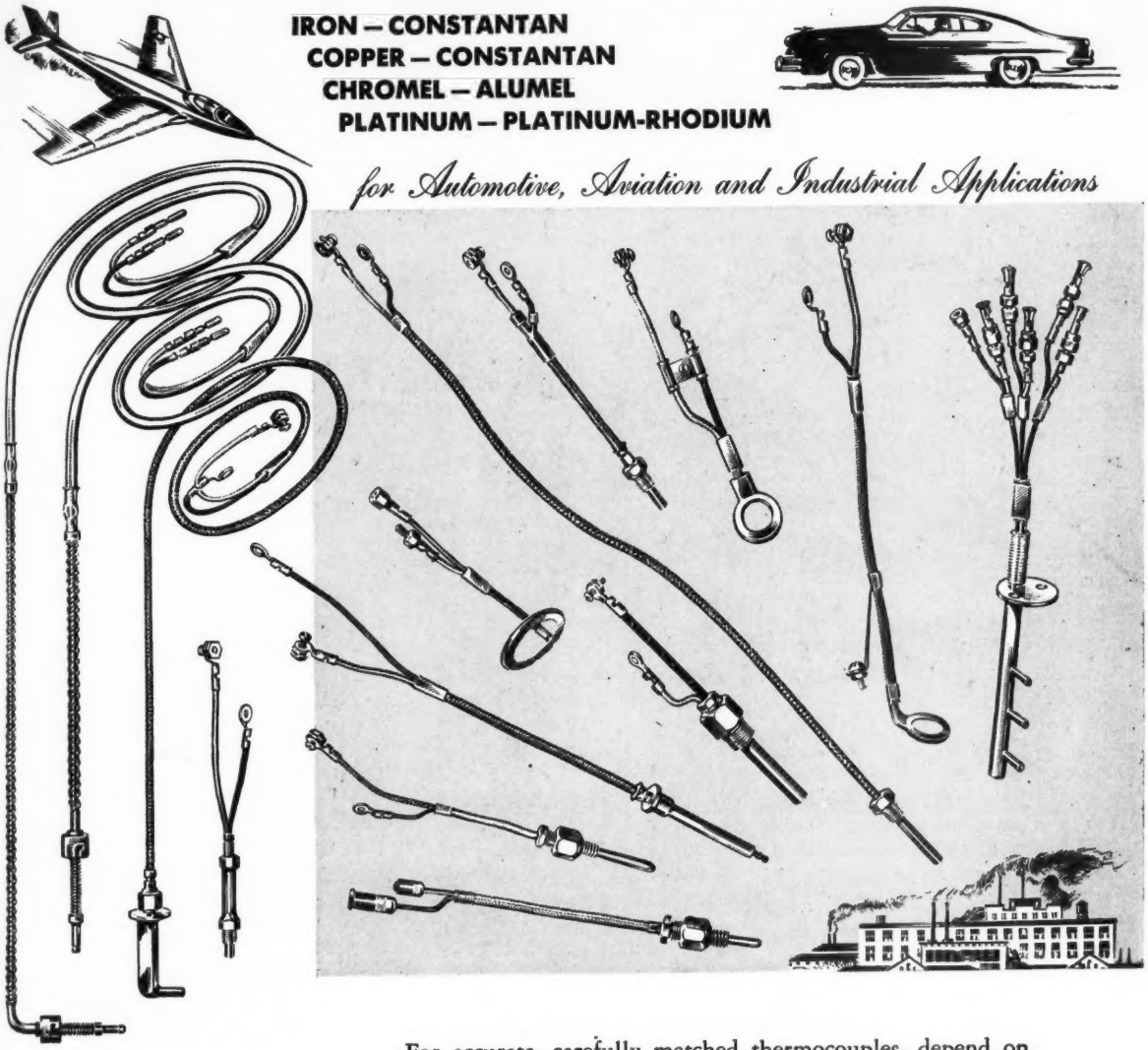
Continued on page 954

THERMOCOUPLES

IRON – CONSTANTAN
COPPER – CONSTANTAN
CHROMEL – ALUMEL
PLATINUM – PLATINUM-RHODIUM

for Automotive, Aviation and Industrial Applications



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For accurate, carefully matched thermocouples, depend on *Lewis* experience to insure satisfactory performance and long service life. Illustrated above are a few of the many styles manufactured, from the bayonet cylinder-head type for aircraft reciprocating engines to the specialized designs for gas turbines.

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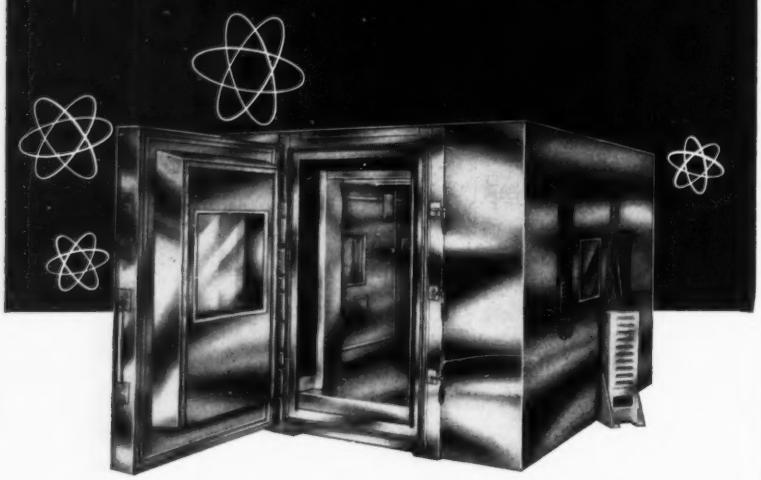

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COVER STORY

The technician in the picture is shown adjusting the frequency of a Hewlett-Packard "Model 200C" audio oscillator. The output of the oscillator is connected to a line filter on a rack of Lenkurt "Type 33" telephone carrier equipment. The output from the filter is being measured on a Ballantine "Model 300" electronic voltmeter. A Lenkurt "Type 612A" transmission measuring set is also shown (on the right) and it could be used in place of the voltmeter for this test setup. Test setup includes an Ohmite decade resistance box.

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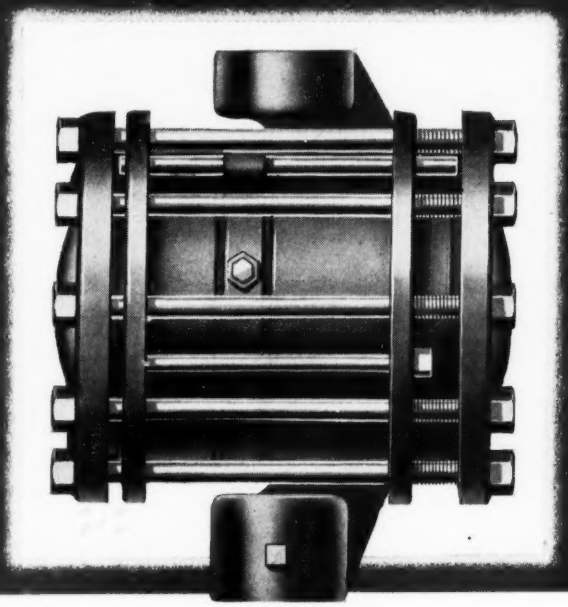

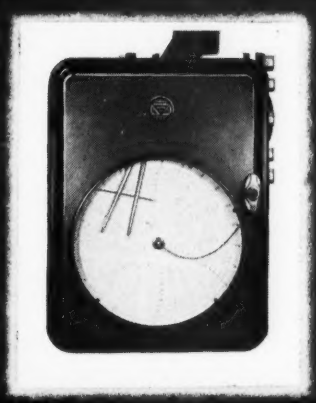

Dri-Flo Orifice Meters combine the accuracy, dependability and low maintenance long noted in American Wetcon Orifice Meters, available for applications where mercury manometers are undesirable. For working pressures to 1000 P.S.I., ambient temperatures of —25° to 175°F.

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- **EASY CALIBRATION AND CLEANING**—by simply removing one or both case cover heads.

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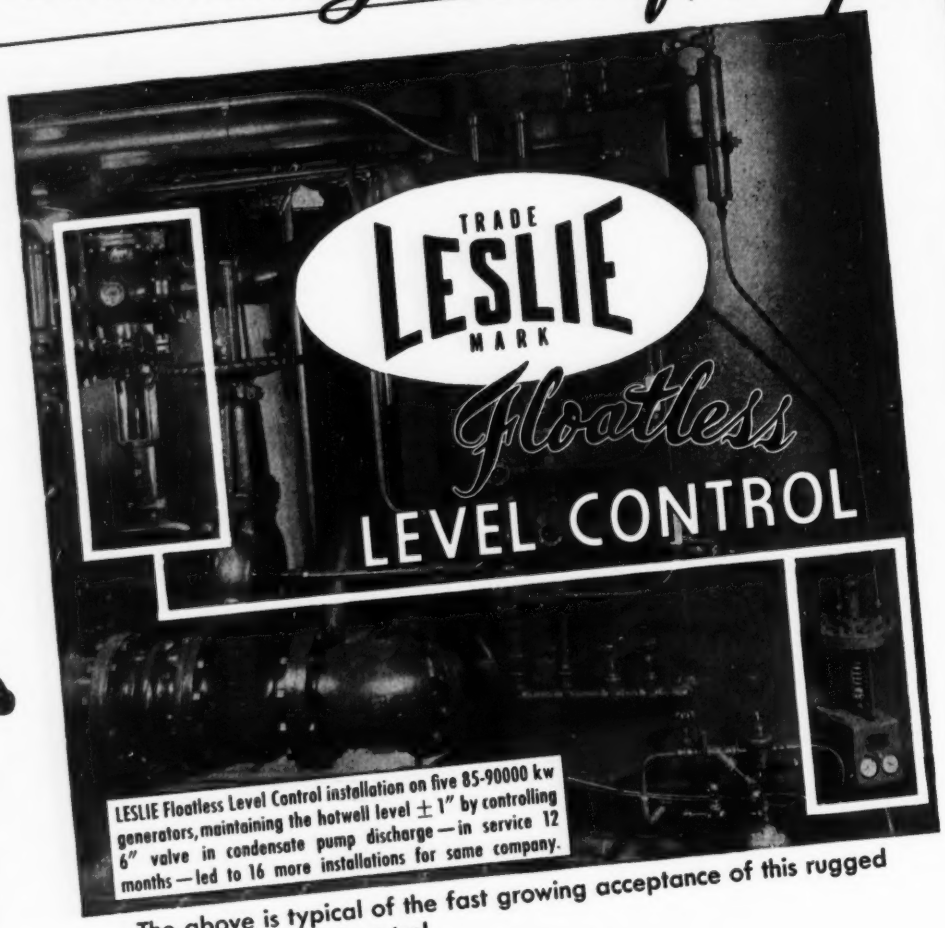

LESLIE Floatless Level Control installation on five 85-90000 kw generators, maintaining the hotwell level ± 1" by controlling 6" valve in condensate pump discharge — in service 12 months — led to 16 more installations for same company.

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The Megger Tester has, over the years, become an integral part of electrical operations everywhere. Through its inherent qualities of ruggedness, accuracy, and dependability it has earned for itself the enviable distinction of being the most widely accepted device for measuring electrical resistance.

Right in stride with today's pace of production, the Megger Insulation and Resistance Tester is demonstrating, in severe industrial service, that it is the most practical and economical means for making insulation resistance tests within the ranges of the available Megger instruments.

MEET THE WHOLE FAMILY

On the next page we have illustrated and briefly described the instruments which now comprise the Megger Family of Insulation and Resistance Test Sets—all represent variations of and improvements on the original Megger Tester.

(over)

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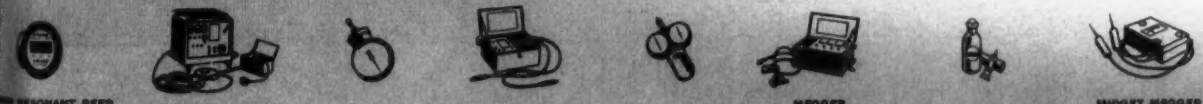

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One of the outstanding characteristics of all types of Megger instruments is quality of a high order. The performance and endurance records which these instruments have achieved are difficult, if not impossible, to match in any type of portable testing device. For insulation resistance measurements Megger instruments are *the recognized standard*. Today more than ever they are "indispensable tools" for electrical preventive maintenance and other electrical resistance testing in the field, plant, or laboratory.

Such developments as the rectifier-operated and dual-operated (hand or rectifier) sets perform repetitive tests more conveniently, more effectively, than can be done by hand cranking. Conversely there is no substitute for the hand generator in the field and for emergencies where supply current is unavailable.

HEAVY-DUTY TYPE MEGGER INSULATION TESTERS

Standardized ratings up to 50,000 megohms and 2,500 volts d-c with d-c generator for either hand or motor operation. Special ranges up to 100,000 megohms and 5,000 volts d-c.

Bulletin 21-20-IN.

MEG TYPE OF MEGGER INSULATION TESTERS

These light weight, easy-to-use instruments are available with ranges up to 2000 megohms, 1,000 volts d-c. Optional accessory features include ohm scales 0 to 10,000 ohms and ratio and discharge switches. *Bulletin 21-45-IN.*

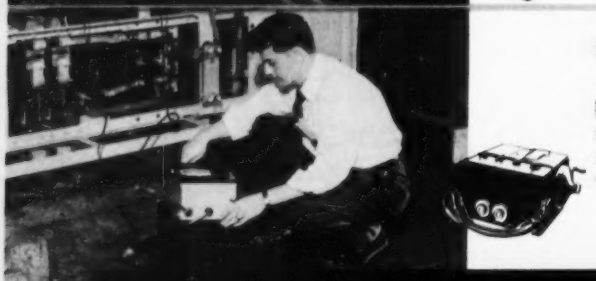
RECTIFIER-OPERATED and DUAL-OPERATED MODELS are available in the same ranges for repetitive production or inspection tests. Complete details in *Bulletin 21-46-IN.*

MIDGET MEGGER INSULATION TESTER

Weighs only 3 pounds and is completely self-contained. A handy tool kit instrument; ratings up to 50 megohms, 500 volts d-c.

CVM CONSTANT-VOLTAGE TYPE MEGGER TESTER

Standard ranges up to 50 megohms, 500 volts d-c, with built-in constant voltage generator; ohm scale and selector switch optional. Both instruments described in *Bulletin 21-85-IN.*



BRIDGE-MEG INSULATION *and* RESISTANCE TEST SET

A Wheatstone Bridge and the Meg Type of Insulation Tester combined in one instrument which performs practically every electrical resistance measurement from a fraction of an ohm up to 1000 megohms. The addition of the Varley Loop feature is optional. For versatility and convenience this instrument is unsurpassed.

Ask for *Bulletin 21-60-IN.*

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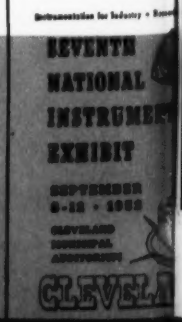

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JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT

Rotameters Offer Definite Advantages In Metering Fluid Rate of Flow

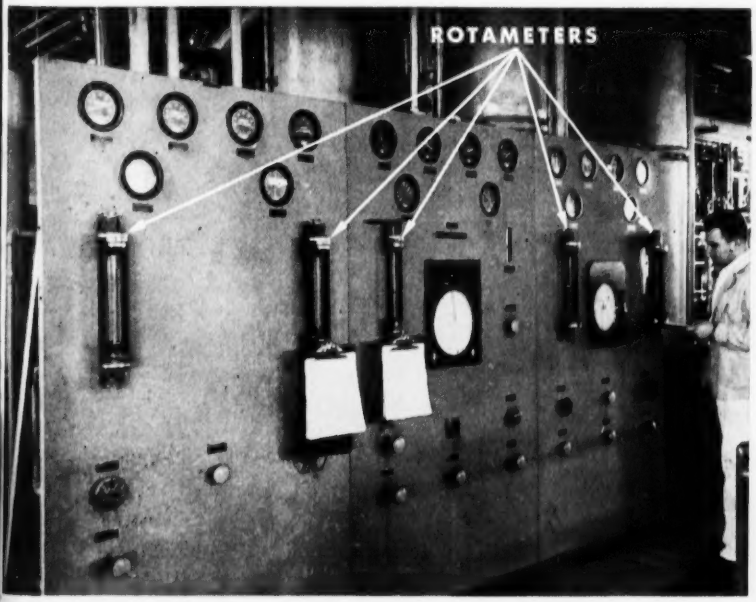
(On-The-Job Photos by Courtesy of Hoffmann-LaRoche, Inc., Nutley, N. J., Manufacturers of Pharmaceutical Chemicals and Vitamins)

In the modern plant of Hoffmann-LaRoche, Inc., in Nutley, N. J., SK Universal Rotameters are used in large numbers to measure fluid flow rates in the manufacture of pharmaceutical chemicals and vitamins.

In metering rate of flow, Rotameters offer definite advantages. They are fast and accurate—are easy to read. Since they have only one moving part, the rotor, maintenance is very simple. Cleaning is easy and fast since the Rotameter can be dis-assembled without disturbing pipe connections. They are versatile in that they can be designed to meet varying requirements.

The SK Universal Rotameter is suitable for most applications, however, many other types are available. These other types include: Chemical, Armored, Flow Alarm, Electronic Recording, Pneumatic Recording, Laboratory, Bypass, and other Rotameters. Each type offers definite construction and operation features of value to anyone desiring to measure fluid rate of flow.

All types are based upon the same basic principles of operation. Fluid enters the tapered meter tube at the bottom and leaves at the top. The fluid exerts a force on the rotor which is proportional to the rate of flow and holds the rotor in a steady position in the tube for any rate of flow within the range of the meter. The rotor position in regard to the scale on the meter tube indicates the rate of flow.



The SK ENGINEERING NEWS, published quarterly in magazine form, contains articles on principles and applications of equipment manufactured by Schutte and Koerting Company. We will gladly add your name to the NEWS' mailing list.

Bulletin 18-RA pictures and briefly describes all types of SK Rotameters and lists, by number, the detailed bulletin relating to each. Request a copy.

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Radically new operating principle . . . Simplest Installation

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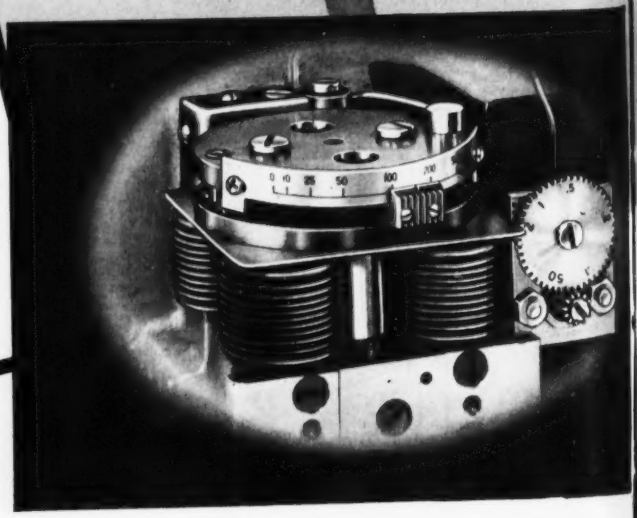
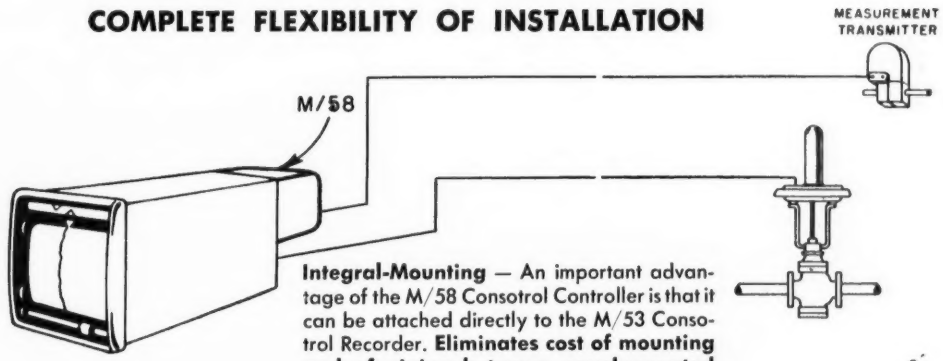
The unique "floating-disc" balancing system is shown here with dial-type reset adjustment. Derivative unit, when required, is plugged in at left of assembly. Both are readily removed or added in the field — both employ new-design adjustable restrictors providing 1000-to-1 range-ability, perfect reproducibility, and consistent rates on both increasing and decreasing air pressure. Proportional band is a lever setting, fully adjustable from 0 to infinity!

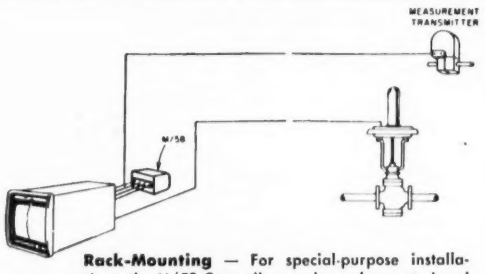


M/58 CONTROLLER

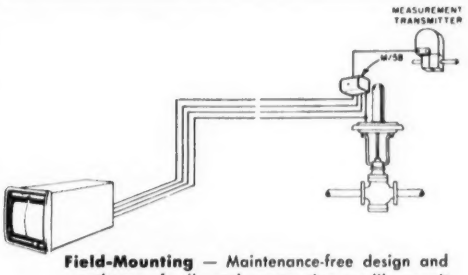
COMPLETE FLEXIBILITY OF INSTALLATION



Integral-Mounting — An important advantage of the M/58 Consotrol Controller is that it can be attached directly to the M/53 Consotrol Recorder. **Eliminates cost of mounting and of piping between panel-mounted recorder and the controller.**



Rack-Mounting — For special-purpose installations, the M/58 Controller can be rack-mounted and piped to the M/53 Consotrol Recorder or comparable unit.



Field-Mounting — Maintenance-free design and weatherproof, all-metal construction readily permit this usage when the process requires it.

Over and above its extreme compactness for graphic panel use, the new Foxboro M/58 Consotrol Controller offers unique advantages in its simplicity of design, unmatched performance, and ease of installation.

This Controller employs an exclusive, simplified balancing system in which the measurement, proportional, reset, and derivative bellows act on a single "floating-disc". With no diaphragms, only one nozzle, and only one moving part, it gives control action unrivalled in stability, sensitivity, and with positive, drift-free control point.

Installation, also, is radically simplified. The M/58 is designed to attach directly to the M/53 Consotrol Recorder (eliminating cost of piping and mounting) or, optionally, to be mounted in remote locations if required.

Write for Bulletin 463 containing full details of the M/58 Controller together with the full line of Consotrol Instruments. **The Foxboro Company, 468 Neponset Avenue, Foxboro, Massachusetts, U. S. A.** Branches in principal cities.

FOXBORO instruments

Reg. U.S. Pat. Off.

INDICATING • RECORDING • CONTROLLING

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

Slow leaks can be expensive

HOW SLOW?

10 years 20 years 30 years

Leak Detector Model 24-101A *detects, locates* and *measures* any leak down to the almost unbelievably minute range where it would require 31 years for one cubic centimeter of gas to escape.

HOW EXPENSIVE?

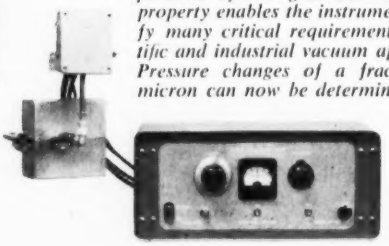
IF YOU are working with critical processes or equipment such as hermetically sealed instruments or glass-to-metal seals required in television camera tube assembly, then you know very slow leaks can be costly. In many of these low-volume, low-pressure applications this mass spectrometer type leak detector is the only instrument sensitive enough for the job.

This instrument is also ideal for less critical work—checking industrial vacuum equipment, high pressure cylinders, compressors moving on an assembly line, valves, welded and soldered joints. Write for Bulletin CEC 1801.

Consolidated Engineering
CORPORATION

300 North Sierra Madre Villa, Pasadena 8, California
Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, Philadelphia, Chicago, Dallas.*

analytical instruments for science and industry



MICROMANOMETER, MODEL 23-105 *provides precise absolute pressure measurements in the micron range (0.1 to 150 microns) without knowledge of the composition of the gas. This remarkable property enables the instrument to satisfy many critical requirements in scientific and industrial vacuum applications. Pressure changes of a fraction of a micron can now be determined.*

ULTRA-SENSITIVE

DC MICROAMMETER

RCA WV-84A

Battery-operated . . . completely portable

FEATURES:

- Reads from 0.0002 microampere to 1000 microamperes in six ranges. Will indicate current flow below one-billionth ampere.
- Can be used with external battery to measure extremely high resistance values in the order of billions of ohms.
- Meter movement electronically protected against burnout.
- Can be used as a voltmeter (external multipliers included) to measure voltages from 0.1 volt to 10 volts at input resistances from 100 to 1000 megohms.
- Voltage drop for full-scale deflection on all ranges is only 0.5 volt. Has 50-megohm input resistance on lowest range.
- Battery-operated for excellent stability and complete freedom from effects of power-line voltage fluctuations. Readily portable.

$100.00, Suggested User Price (Batteries not included).

SPECIFICATIONS:

SIX DC CURRENT RANGES:
0 to 0.01, 0.1, and 1 microampere: 0 to 10, 100, and 1000 microamperes.

ACCURACY:
On 0.01-Microampere Range . ± 5% of full scale
On All Other Ranges . . . . . ± 4% of full scale
Voltage Drop for Full-Scale Deflection
. . . . . 0.5 volt on all ranges

INTERNAL SHUNT RESISTANCE:
0.01-Microamp Range . . . . . 50 megohms
0.1-Microamp Range . . . . . 5 megohms
1-Microamp Range . . . . . 0.5 megohms
10-Microamp Range . . . . . 50,000 ohms
100-Microamp Range . . . . . 5,000 ohms
1000-Microamp Range . . . . . 500 ohms

POWER SUPPLY:
"A" Batteries . . . . . 2, 1½ volts (RCA-VS106)
"B" Batteries . . . . . 2, 22½ volts (RCA-VS102)

DIMENSIONS:
9½" High, 6¼" Wide, 5¾" Deep

WEIGHT:
9½ lbs. (incl. batteries).

Useful in laboratories, industrial plants, broadcast stations . . . for the measurements of minute currents, critical voltages, high resistance

The RCA-84A Ultra-Sensitive DC Microammeter is a battery-operated vacuum-tube microammeter designed for the measurement of minute direct currents. The instrument has six scales for reading currents from 0.0002 microampere to 1000 microamperes; a ratio of 5,000,000 to 1.

The amplifier circuit is designed so that the maximum meter current is limited to a safe value. This feature protects the instrument against meter burnout. The meter has a large face with wide scale divisions that are easy to read accurately. The meter movement is suitably damped to bring the pointer quickly to its reading position with negligible overswing and without oscillation. The selector switch opens the battery circuits when in the "off" position, and, in addition, functions as a polarity-reversing switch to eliminate the need for reversing leads when the current polarity changes.

The vacuum tubes employed have low-drain filaments. In addition, the circuit has been designed to keep the plate current low. Consequently, batteries have an exceptionally long life.

• • •

Ask your *RCA Test Equipment Distributor* for descriptive bulletin, or write RCA, Commercial Engineering, Section HX 68, Harrison, N. J.

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RADIO CORPORATION of AMERICA

TEST EQUIPMENT — **HARRISON, N. J.**

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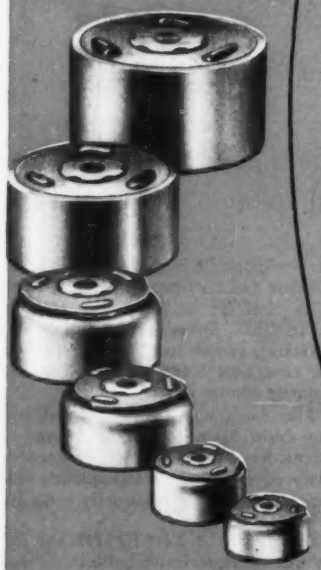
INSTRUMENT EXHIBIT
SEPTEMBER 8 TO 12
CLEVELAND MUNICIPAL AUDITORIUM
CLEVELAND, OHIO

PROBLEM... Dependable power in a small package!

SOLUTION... LEDEX ROTARY SOLENOIDS



The powerful *rotary* action of Ledex Solenoids is at work delivering dependable snap-action in a multitude of products. Ledex engineers will work with you to produce the most efficient applications of Ledex Rotary Solenoids for your products.

Available in six sizes . . . rotary strokes up to 95° . . . torque up to 50 pound-inches . . . with many types of power linkages. *Write today for complete information.*

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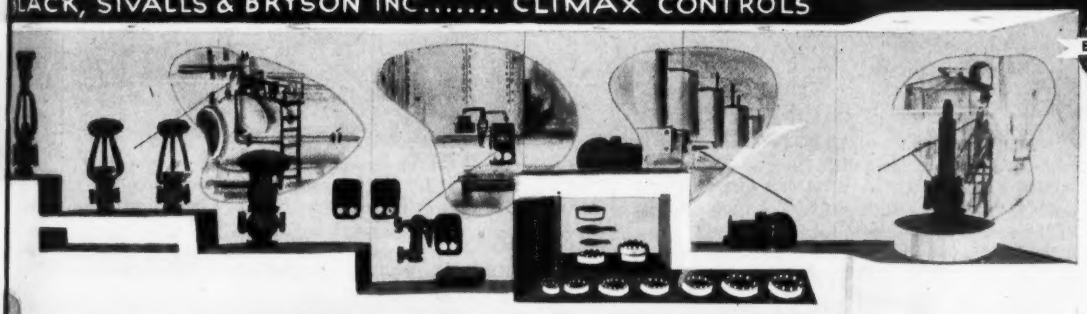
LACK, SIVALLS & BRYSON INC..... CLIMAX CONTROLS



BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-V8 7500 East 12th Street, Kansas City, Missouri

THE MICROSEN BALANCE

AN UNPARALLELED ADVANCE IN THE APPLICATION OF

ELECTRONIC COMMUNICATION

TO PROCESS CONTROL

THE MICROSEN BALANCE is a compact, modified Kelvin Galvanometer structure—operates automatically on the force balance principle. It transduces mechanical motions into electrical signals and vice versa—is equally effective for the stable amplification of electrical signals.

A calibrated spring converts mechanical motion to force loading of a pivoted beam. The tuning of a high frequency oscillator coil, adjacent to the beam, detects the balance conditions of the beam and varies the current flow in the circuit accordingly. The rectified oscillator output — .5 to 5 milliamperes — serves as the transmission signal. A calibrated portion of this signal is fed back to an actuator coil, attached to the underside of the beam, which operates in a permanent magnetic field. This electrical feedback signal applies a force opposed to the mechanical input force.

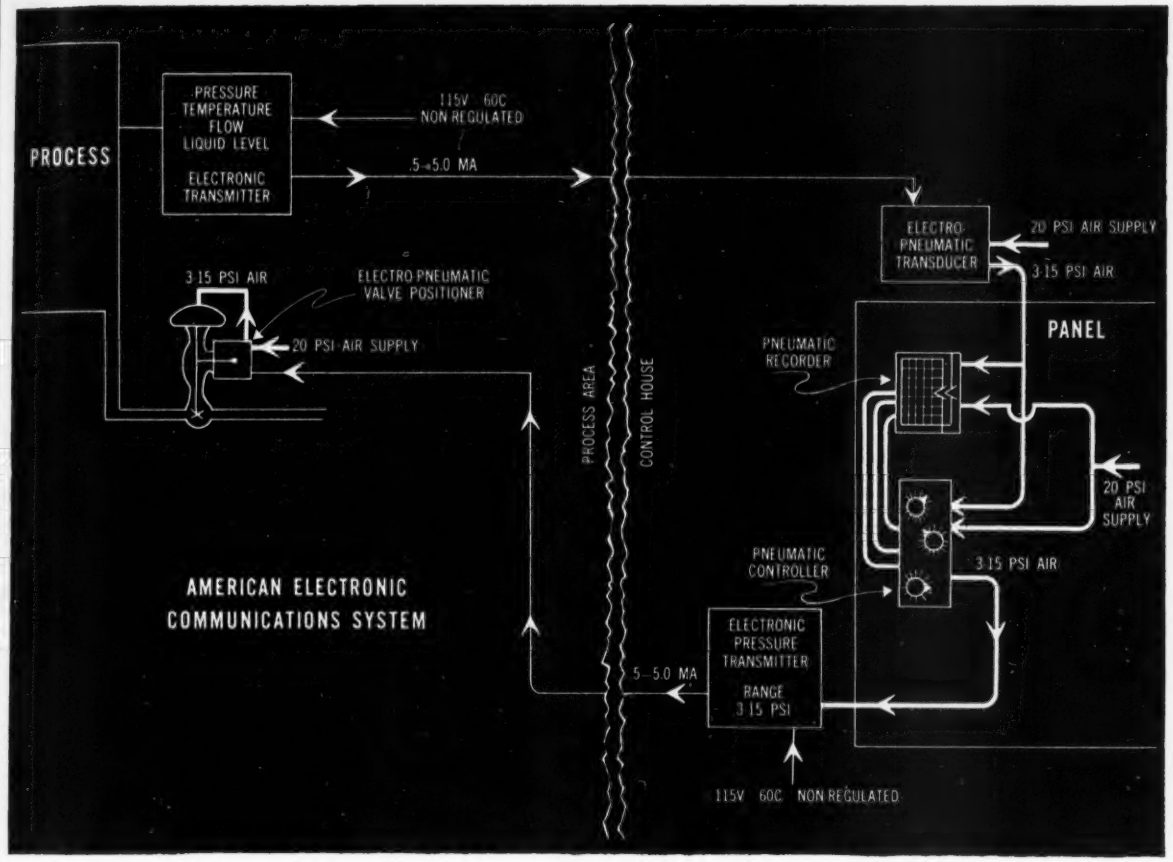
Whenever the two opposing forces become unequal, equilibrium is immediately reestablished by the movement of the beam which either increases or decreases the magnitude of the output current. Output current value is constantly compared with the mechanical input value. Thus, the Microsen Balance insures a linear current signal proportional to the mechanical input and independent of the transmission circuit resistance, up to a maximum of 3,000 ohms.

The Microsen Balance—used in all American Electronic Instruments—*instantly* transmits *pressure, temperature, flow* and *liquid level* information to the panelboard and controller signals to the valve. It provides these advantages of electric communication:

1. Virtually eliminates transmission lags by restricting the use of pneumatic lines to control boards. (The average signal delays over 500 feet of transmission line are 10 seconds for pneumatic, 5 x 10^{-7} seconds for electric).
2. Eliminates all distance considerations.
3. Assures superior performance in process control by high speed response. All changes are detected and corrective measures are initiated

THE MICROSEN BALANCE

AMERICAN



practically instantaneously. This type of "tight" control envisions smaller process equipment for given throughput.

4. Makes all adjustments readily accessible to one operator in the control room.
5. Eliminates freeze-ups of pneumatic lines. Climatic conditions can be completely disregarded.
6. Replaces four pneumatic lines from the panel loading station to the controller at the valve by a simple, two-wire circuit. (Pneumatic controllers must often be located near the valve in order to reduce response delays.)
7. Reduces signal line maintenance.
8. Permits the utmost flexibility through the current type signal. Any number of receiving instruments may be located in a single transmission circuit. Signals are additive for control function computation using two or more input signals.

Elements in the American Electronic Communications System are:

ELECTRONIC TRANSMITTER. Types to transmit pressure, differential pressure, temperature, flow or liquid level. Produce a .5 to 5 milliampere current signal proportional to the magnitude of the variable being measured. Constantly compare electrical output with the magnitude of the measured variables—insure accurate and linear output.

ELECTRO-PNEUMATIC TRANSDUCER. One type utilizes an electronic amplifier and may be used for very low-level signal inputs such as derived from thermocouples. Another type incorporates a mechanical or pneumatic type amplifier — is especially suited for use with the transmission signal of .5 to 5 milliamperes. Both convert electrical input to proportional pneumatic output. They provide the means for utilizing pneumatic recorders and controllers now widely used. Constantly compare the pneumatic output of 3 to 15# of air with the electrical input signal—assure linearity and accuracy.

CONTROLLERS. Pneumatically operated. Widely used with indicators and recorders of the pneumatic type. Some are built integrally with these units or as separate units in the stacked type.

ELECTRONIC PRESSURE TRANSMITTER. Converts air output from controller into an electrical signal.

ELECTRO-PNEUMATIC VALVE POSITIONER. Receives .5 to 5 milliampere signal and compares it to the actual displacement or position of the valve stem—produces a pneumatic signal which mechanically operates the valve.

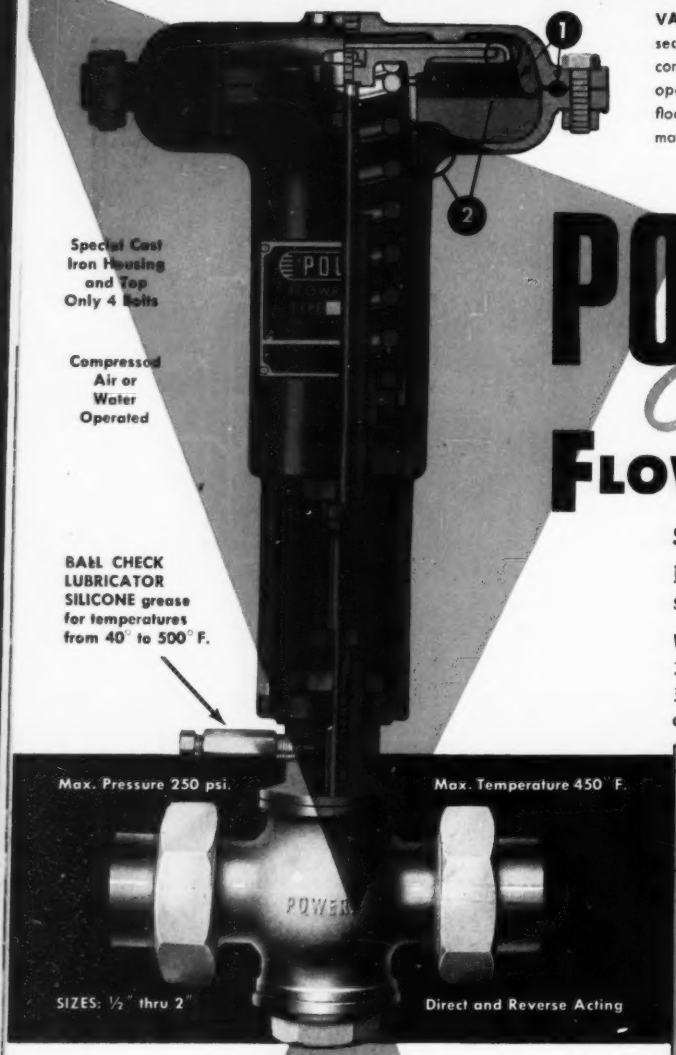
INDUSTRIAL INSTRUMENTS

A product of MANNING, MAXWELL & MOORE, INC. STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

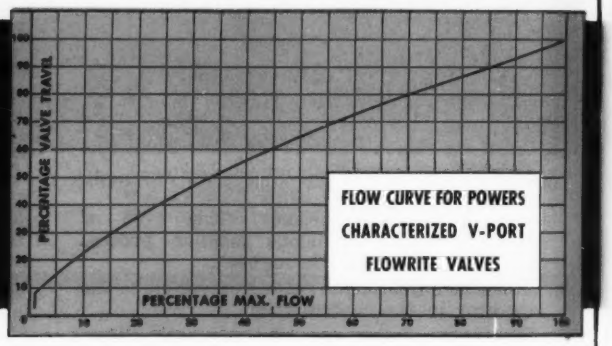
VALVE TOP—Durable moulded neoprene diaphragm (1) has positive sealing bead which provides increased sealing action with increasing control pressure. Efficient diaphragm form insures ample and constant operating power thru full travel. Piston Plate Assembly (2) has a free floating thrust plate which absorbs side thrust. Closely guided piston plate maintains stem in accurate alignment. Maximum air pressure in top, 22 psi.

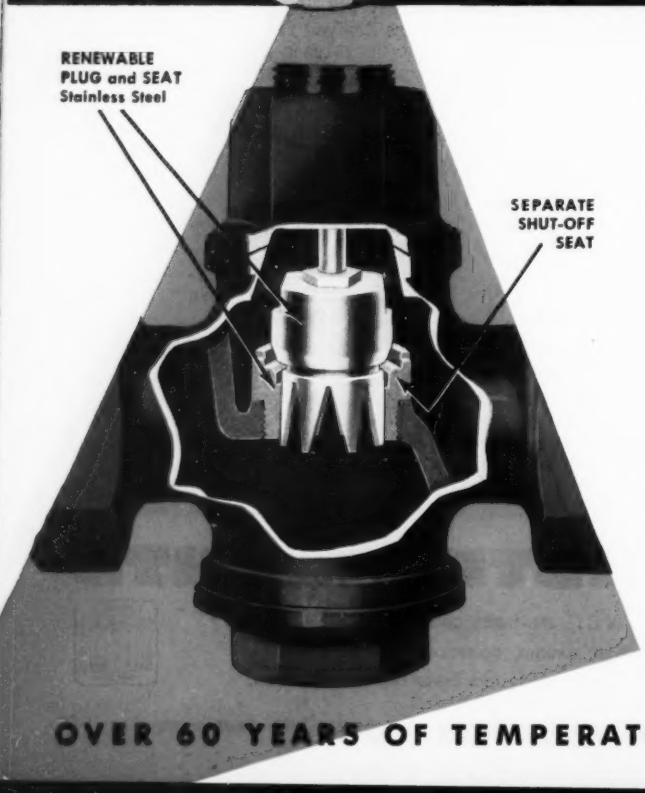
POWERS® SINGLE SEAT V-PORT *Characterized* FLOWRITE VALVES Give–


1
2
Special Cast Iron Housing and Top Only 4 Bolts
Compressed Air or Water Operated
BALL CHECK LUBRICATOR SILICONE grease for temperatures from 40° to 500° F.
Max. Pressure 250 psi.
Max. Temperature 450° F.
SIZES: ½" thru 2"
Direct and Reverse Acting

Special Flow Characteristics—High lift V-Port plug provides proportional flow throughout entire lift of stem as shown in chart below.

Wide Variety of Valve Sizes—Nine sizes are available, ½" thru 2". The ½" valve can be furnished with plugs to give 15%, 30%, 60% or 100% of maximum capacity. Plugs are easily interchangeable without removing valve from line.





Better Control—Less Maintenance—Superior design of stainless steel plug and seat reduces wire drawing, insures longer life and tight shut off. V-Ports do the throttling, protecting separate shut off seat. Plug and seat are truly removable and can be easily replaced in the field. Inner valves are machined and precision ground and lapped within very close tolerances.

Low Hysteresis—Due to smooth rolling diaphragm and polished stainless steel stem in preformed lubricated packing.

Easy to Adjust—Ball bearing adjusting screw; rust proofed steel calibrated springs with full travel in 5 or 10 psi.

Easy to Install—Powers Flowrite V-Port valves have double unions and bronze body with rugged construction to withstand piping strains.

Easy to Service—Valve and top are easy to take apart and re-assemble, facilitating inspection and maintenance.

Reasonably priced. Contact our nearest office for prices and assistance in selecting proper size valves

THE POWERS REGULATOR CO.

SKOKIE, ILLINOIS • Offices in Over 50 Cities

Chicago 13, Ill., 3819 N. Ashland Ave. • New York 17, N. Y., 231 E. 46th Street
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OVER 60 YEARS OF TEMPERATURE AND HUMIDITY CONTROL

BRUSH

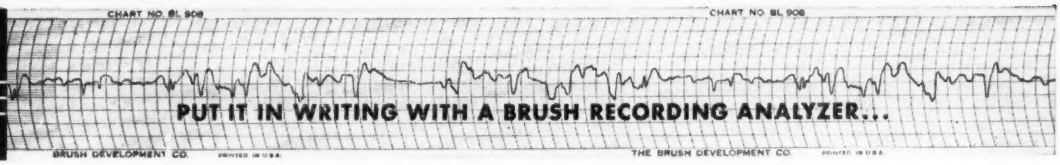
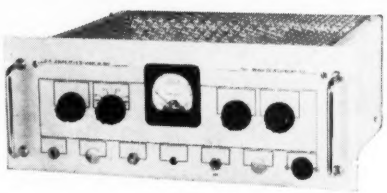


CHART NO. BL 908
CHART NO. BL 908
PUT IT IN WRITING WITH A BRUSH RECORDING ANALYZER...
BRUSH DEVELOPMENT CO.
THE BRUSH DEVELOPMENT CO.

Checks dialing on Micro-wave and Carrier Current Equipment

• Brush Recording Analyzers save plotting and testing time in applications everywhere. Here, at a substation of the Bonneville Power Administration, a Brush direct-coupled dual channel amplifier and dual-channel oscillograph record dialing pulses for a maintenance check. The test immediately indicates any dialing troubles in the system, and their nature. The Brush equipment is also used to check relay operation, and has been found essential to keeping the micro-wave system "on the air". Duplicate Brush equipment is used to service communication facilities in each Bonneville maintenance area.

MEASURES ELECTRICAL VARIABLES . . . CHART AVAILABLE INSTANTANEOUSLY



Brush Direct-Coupled Amplifier for Rack Mounting, Model BL-962.

This high gain, low-drift D-C amplifier is designed for mounting in a standard 19-inch rack. Other Brush amplifiers and oscillographs are being designed for rack mounting. When used in conjunction with Brush direct-writing oscillographs, amplifier can be used to make recordings of many types of phenomena which previously required complicated intermediate equipment. Voltage gain gives one chart millimeter deflection per millivolt input. Frequency response is essentially linear from D-C to 100 cycles per second. (Bulletin F-698)

Direct-writing Two-Channel Magnetic Oscillograph Model BL-202

The Brush Magnetic Oscillograph, used with the proper Brush Amplifier, makes a direct chart recording of voltage or current, or of physical phenomena such as strain, pressure, acceleration, torque, force, temperature, displacement and vibration. Either direct inking or electric stylus models available. Gearshift provides chart speeds of 5, 25, and 125 mm per second. An auxiliary chart drive is available for speeds of 50, 250, and 1250 mm per hour. Accessory equipment provides event markers where an accurate time base is required, or where it is desirable to correlate events. Photo shows two-channel model for recording of two phenomena simultaneously.

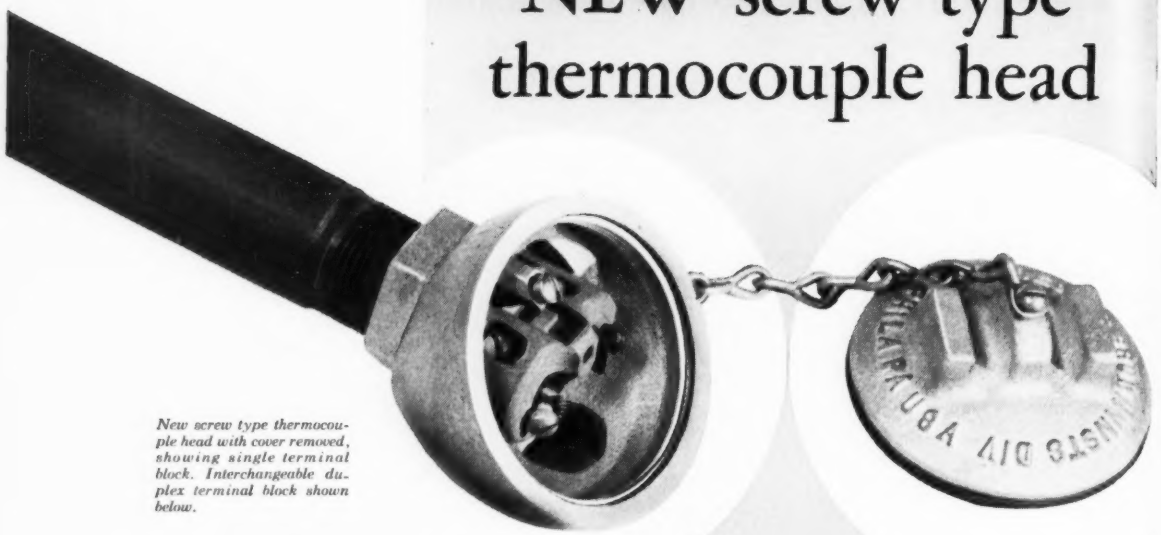
For Bulletin 618 describing these instruments write The Brush Development Co., Dept. A-33, 3405 Perkins Avenue, Cleveland 14, Ohio. Representatives located throughout the U. S. In Canada: A. C. Wickman Limited, Toronto.

THE Brush DEVELOPMENT COMPANY

BRUSH

Piezoelectric Crystals and Ceramics
Magnetic Recording
Acoustic Devices
Ultrasonics
Industrial & Research Instruments

NEW screw type thermocouple head



New screw type thermocouple head with cover removed, showing single terminal block. Interchangeable duplex terminal block shown below.

. . . now available through your

HSM

HONEYWELL SUPPLIES MAN

Here's a new Brown Screw Type Thermocouple Head that *cannot rust or freeze* . . . another plus value in the HSM Plan for convenient and economical purchasing of pyrometer supplies.

This unit effectively safeguards terminal connections from corrosive effects of high temperatures and extreme weather conditions.

Versatile: it accommodates single and duplex thermocouple, and resistance thermometer, terminal blocks . . . is interchangeable with other heads . . . and permits installation of twin thermocouples with a single head. Thus, your inventory of thermocouple heads is materially reduced.

Threads on the inside of the head . . . plus plating and enameling *after* machining . . . prevent freezing and rusting.

Call your local Honeywell Supplies Man for prices and delivery information, and for details on the HSM Plan for all your pyrometer supplies purchases . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

● *Important Reference Data*

Write for a copy of New Pyrometer Supplies Buyers' Guide, No. 100-4

INTERNATIONAL RECTIFIER CORPORATION

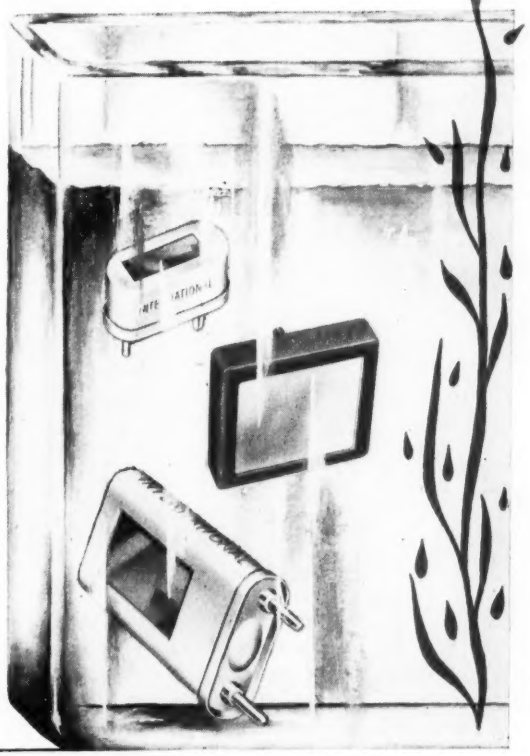
Selenium Photo-Cells

A-2M –
Window: 9/32" diameter. 13 microamperes at 100 foot-candles illumination. Enclosed in a phenolic case with threaded terminals. This unit is not designed for immersion.

DP-2 –
Hermetically sealed. Window: 15/32" x 3/16". 25 microamperes at 100 foot-candles illumination. Terminals fit standard crystal mounting base. Supplied with corrosion-resistant finish.

DP-5 –
Hermetically sealed. Window: 1½" x 1½". 600 microamperes at 100 foot-candles illumination. Corrosion-resistant finish. Threaded terminals.

DP-3 –
Hermetically sealed. Window: 9/16" x 3/8". 50 microamperes at 100 foot-candles illumination. Terminals fit standard crystal mounting base. Supplied with corrosion-resistant finish.



INTERNATIONAL hermetically sealed Photo-cells (DP-2, DP-3, DP-5) are designed for immersion and eliminate the expense of transparent tubing in many applications where light is used to serve as a quality control in manufacturing processes.

STANDARD UNMOUNTED PHOTO-ELECTRIC CELLS

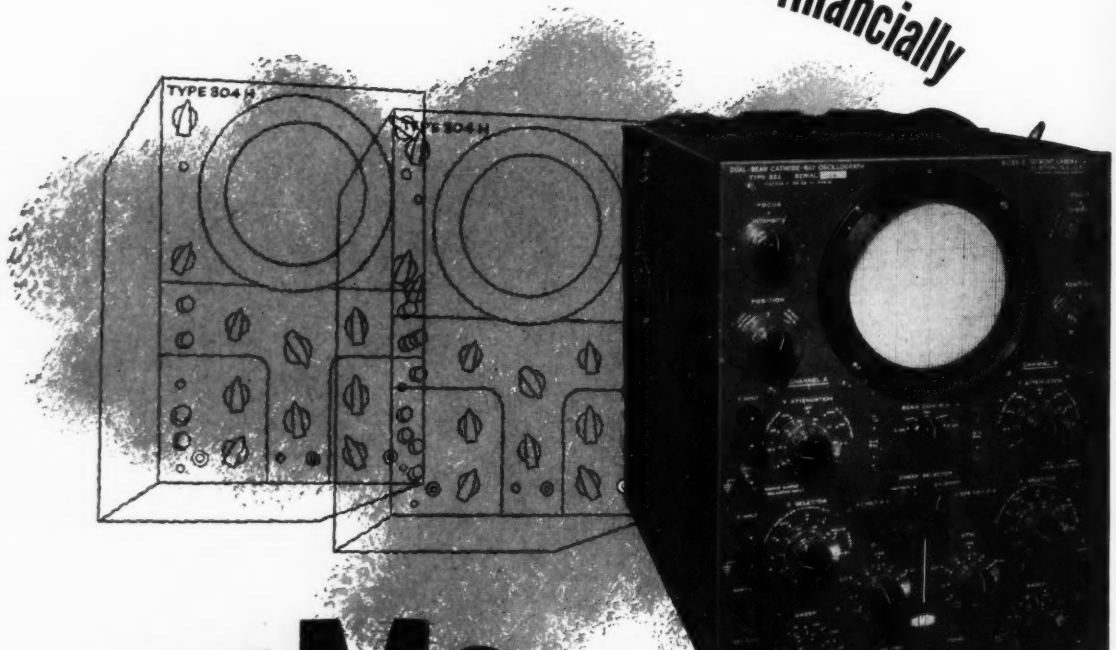
A 15	A 10	A 5	B 10	B 5	B 2
2" diam.	1¾" diam.	1⅛" diam.	1-11/16" x 7/8"	1-7/16" x 41/64"	23/32" x 7/16"
750 microamperes*	500 microamperes*	250 microamperes*	340 microamperes*	220 microamperes*	75 microamperes*

** At 100 foot-candles illumination and 100 ohms external resistance.*

INTERNATIONAL RECTIFIER
CORPORATION

General Offices: 1521 E. Grand Ave., El Segundo, Calif. · Phone: El Segundo 1890
Chicago Branch Office: 205 West Wacker Drive · Phone: Franklin 2-3889

A general-purpose DUAL-beam oscillograph to fit your needs technically and financially



the DU MONT TYPE 322

Not just another specialized dual-beam oscillograph, but a brand-new type designed for general development work but rugged enough for production testing and industrial applications as well. Compactness, lightweight, ruggedness and versatility mark the Du Mont Type 322 as another milestone in cathode-ray oscillography.

FEATURES **All the well-known features of the 304-H, and...**

Thoroughly field-tested.

Individual and common time bases with driven or recurrent sweeps and sweep expansion on all sweeps.

Conventional single-ended input with stepped and vernier attenuators, or balanced input with no attenuation, on both Y-axes.

Concentric controls for easy-to-operate, compact control panel.

High-gain D-C amplifiers on both channels.

Amplitude calibration on either channel on both axes.

Illuminated scale with dimmer control.

SPECIFICATIONS

Cathode-ray Tube — Type 5SP — Dual-beam Cathode-ray Tube. Accelerating potential, 3000 volts.

Y-Deflection Sensitivity — 0.028 peak-to-peak (0.01 rms) volts/inch from D-C to 300 KC (50% down at 300 KC); A-C coupling, 10% down at 5 c.p.s.

X-Deflection Sensitivity — 0.3 peak-to-peak (0.1 rms) volts/inch from D-C to 300 KC (down 50% at 300 KC); A-C coupling down 10% at 5 c.p.s.; common, D-C to 200 KC (down 50% at 200 KC).

Linear Time Base — Recurrent and driven sweeps variable in frequency from 2 to 30,000 c.p.s. Front panel connections provided for lower frequency by adding external capacitance.

Intensity Modulation — Input impedance 0.2 megohm, paralleled by 80 $\mu\mu$f. Negative signal of 15 volts peak blanks beam at normal intensity settings.

Beam Control Switch — On front panel to turn beams on or off independently or simultaneously.

Calibrator — Regulated potentials of 50 millivolts and 1 volt peak-to-peak squarewave at power line frequency available at front panel binding posts.

Power Source — 115/230 volts — 50-400 c.p.s. — 225 watts.

Dimensions — Height 15¾", width 12½", depth 22⅞", weight 75 lbs.

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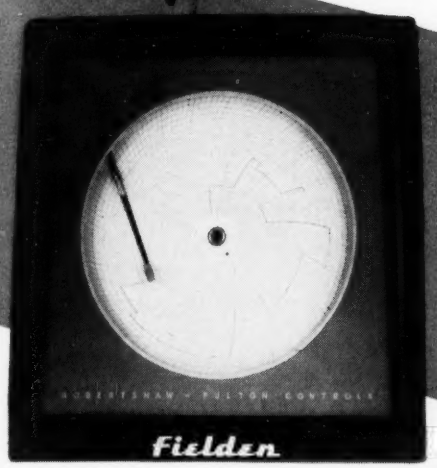

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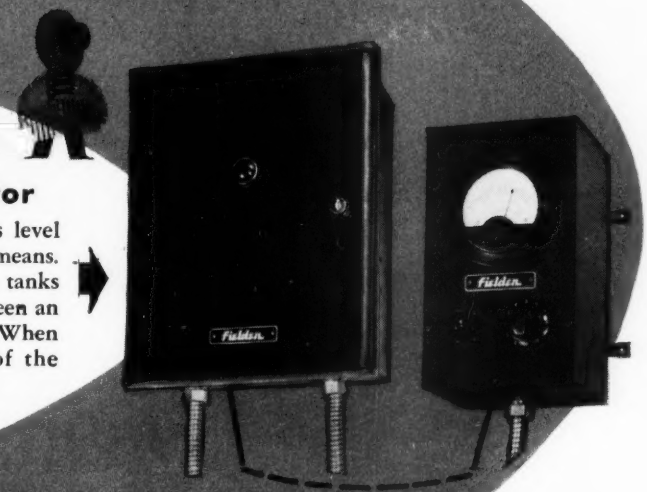

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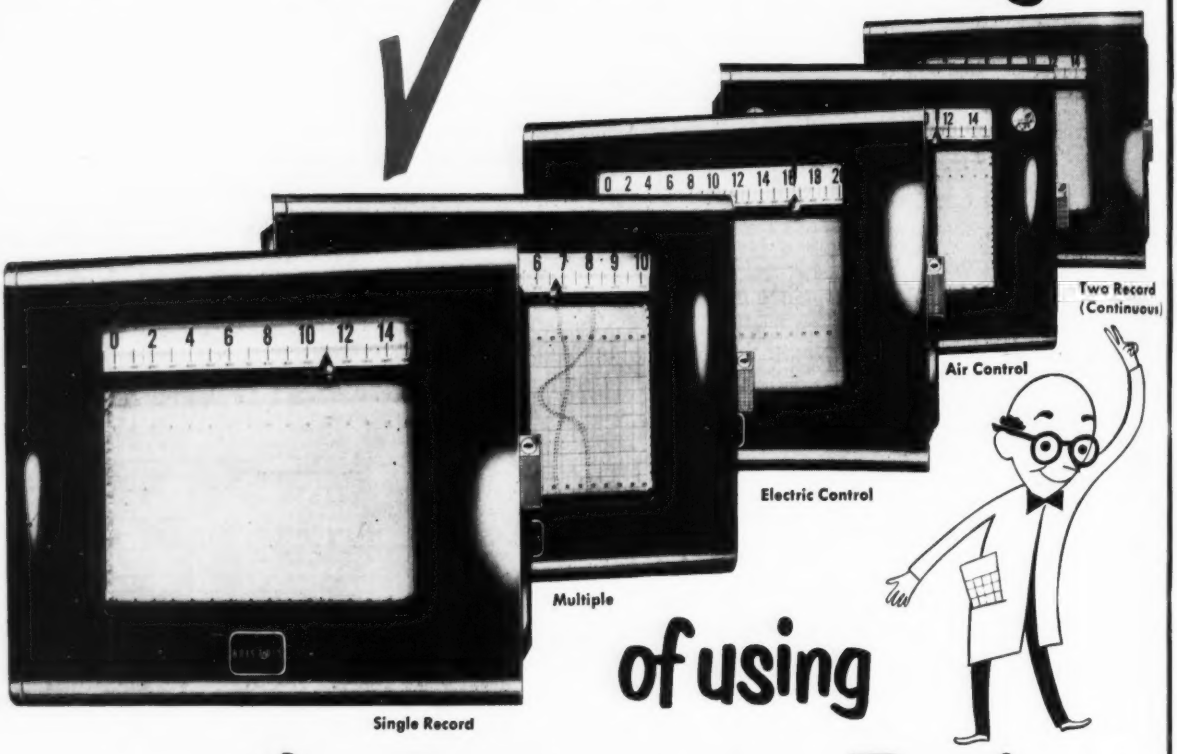

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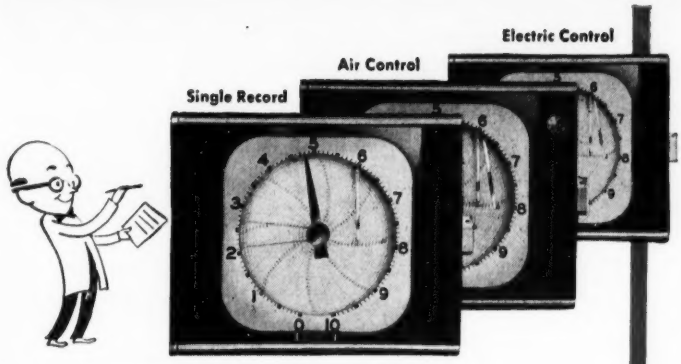

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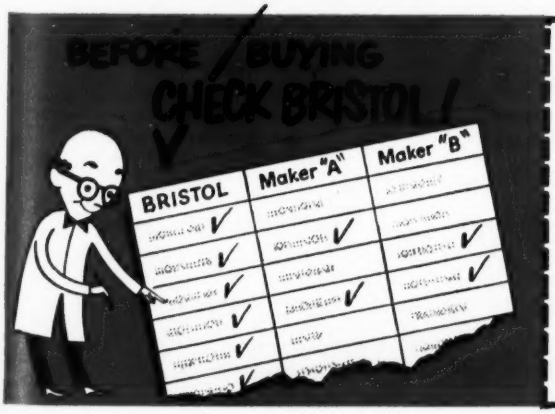

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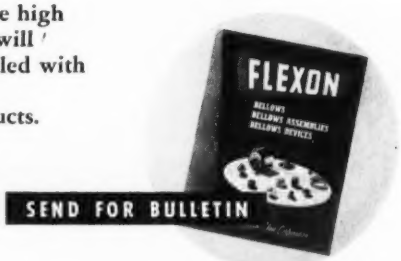

The FLEXON Bellows Design Guide gives full information on FLEXON Bellows as well as useful data on selection of bellows. Write for a copy.

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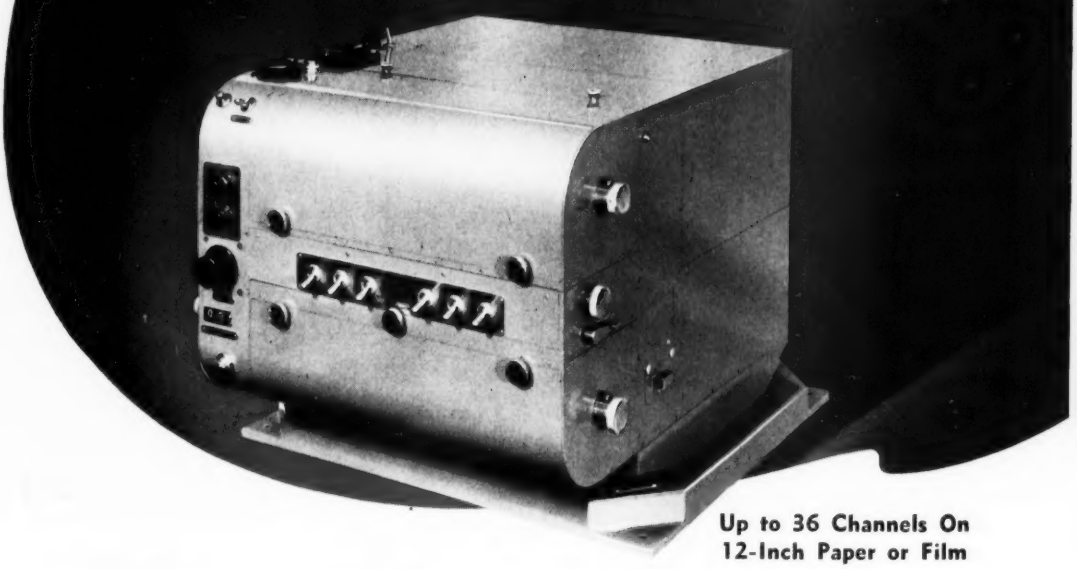

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Midwestern Model 570 Oscillograph

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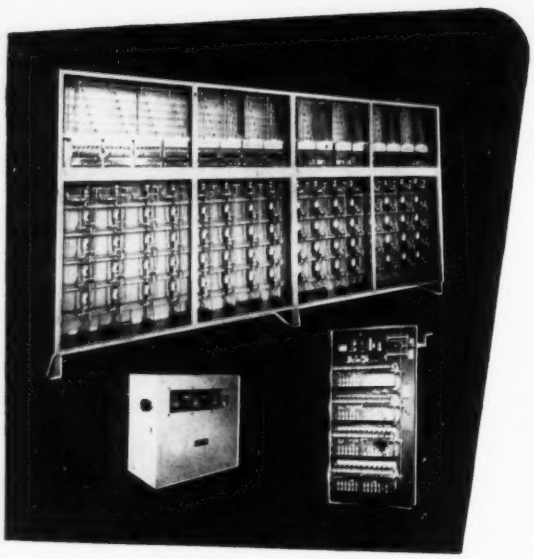

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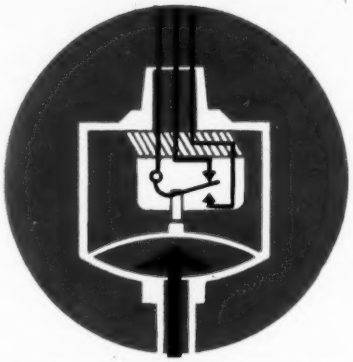
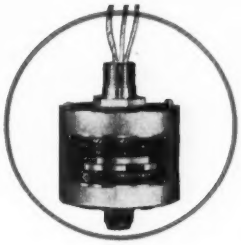
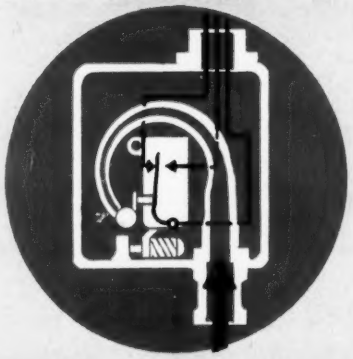


DIAPHRAGM TYPE

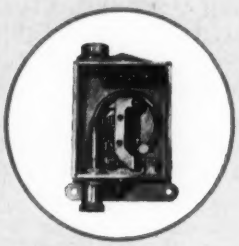
For vacuum and low pressure (to 120 psi) applications. Adjustable range from 30" of mercury to 120 psi pressure, available in 10 classes of switches. Berylium copper diaphragm sensing element. Pressure port ⅛-27 or ¼-18, electrical connection ½" conduit.

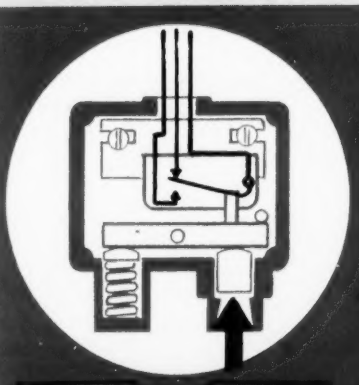




BOURDON TUBE TYPE

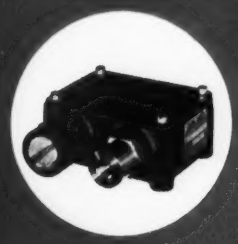
For higher pressures (to 10,000 psi). Available in 6 classes of adjustable ranges from 15 to 10,000 psi with proof pressures ranging from 500 to 15,000 psi. Duronze and SAE 4130 Bourdon tube sensing element. Pressure port ¼-18, electrical connection ½" conduit.





PISTON TYPE

For heavy duty industrial applications. Six classes of piston type pressure sensing elements provide operating ranges from 50 to 10,000 psi. Proof pressure to 15,000 psi. Pressure connection ¼-18, electrical connection ½" conduit.



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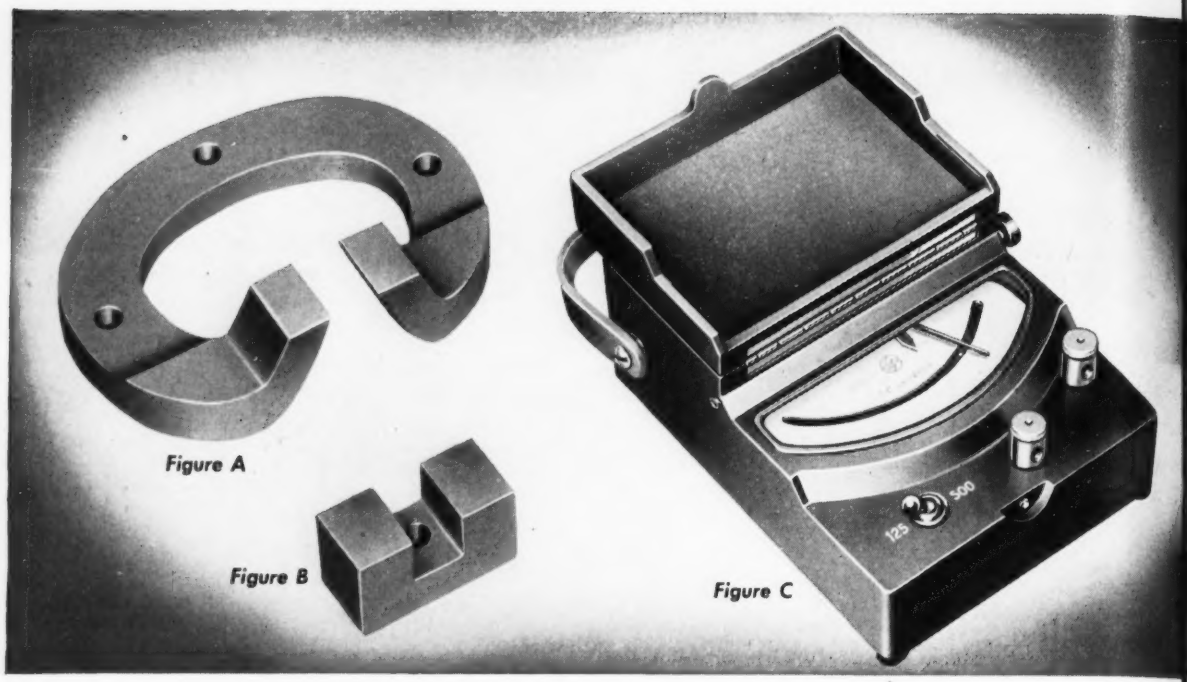

INSTRUMENTS—Fig. A is a damping magnet formerly used in GE portable indicators. Fig. B is the new Carboloy Alnico magnet now used. Its smaller size permitted improved instrument design and lower magnet cost with no decrease in efficiency. Fig. C. New magnet also speeds assembly, makes faster and easier calibrations.

How Carboloy permanent magnets improve electrical products

CONTROLS—Switches in compact Minneapolis-Honeywell controls use permanent magnets to give safer snap action, help quench arcs. The magnets are exceptionally stable; provide uniform high energy for the life of the control.

Want to cut down product size, weight? Build a better-performing product for less money?

Then check the possibility of using Carboloy Alnico permanent magnets wherever you need *lasting* magnetic energy.

Carboloy permanent magnets are simple, self-containing sources of energy that *never* fail. They are powerful in small sizes. Need no outside power supply, no maintenance. They help reduce fabrication costs by eliminating wires, coils and operating parts. Above all, they let you simplify design . . . build a lighter, more compact, finer-performing product at a saving.

On these pages you'll see how others got the jump on competitors by using permanent magnets. Perhaps you'll get an application idea from reading about them.

FREE SERVICES

If so, check Carboloy magnet engineers for free, expert advice and an assist in design and application. Look to Carboloy production lines, too, for the uniform, high-energy Alnico magnets you'll need for best results — all sizes, all shapes; cast or sintered to your specifications.

Send coupon for free Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

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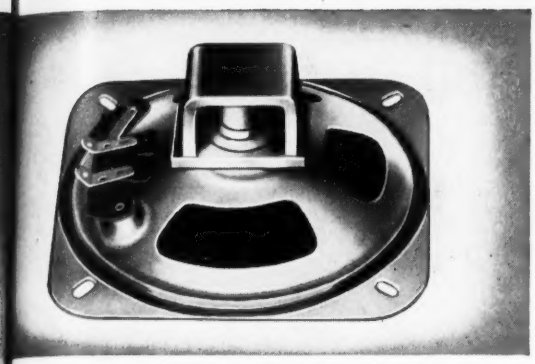
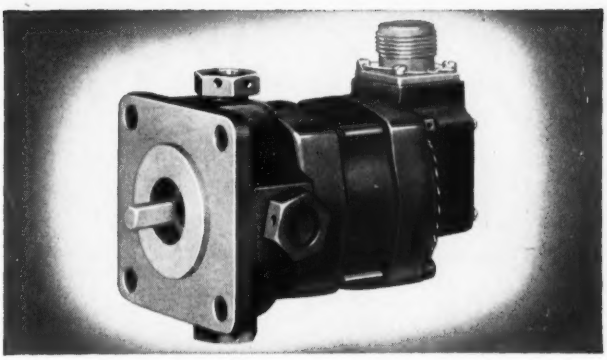


SPEAKERS — In speakers, permanent magnets replace larger electro-magnets in field structure. Current passing through Alnico's *uniform* field makes voice coil and cone vibrate in proportion to voltage; tone is truer.



GENERATORS—When GE engineers had only 6" x 6" area for jet's tachometer generator, they whipped design problem with a tiny permanent magnet. It eliminated coils and wires, supplied the powerful energy required.

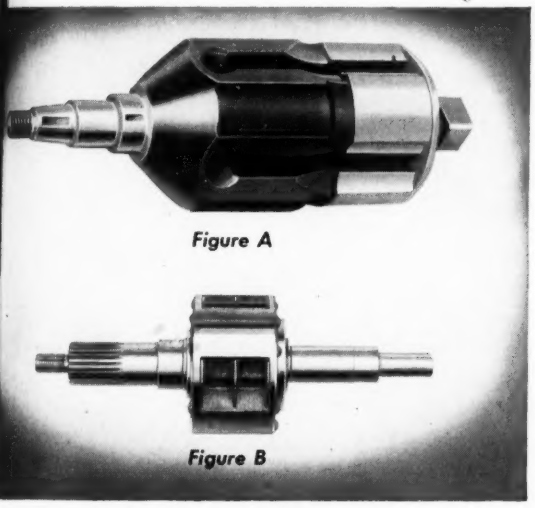


Figure A

Figure B

MAGNETOS — To Scintilla Magneto Division, Bendix Aviation Corp., weight savings are vital in their aircraft products. Fig. A shows chrome rotor weighing approximately 4 lbs. 9 ozs. Fig. B shows newer model rotor using Alnico. It weighs only 2 lbs. 4 ozs.

ADVANTAGES OF CARBOLOY PERMANENT MAGNETS

1. Simple — no operating parts
2. Uniformly powerful
3. Last forever
4. No coils to wire
5. Cool-running
6. No operating costs
7. No power failures
8. Combine electrical and mechanical features
9. Simplify mechanical assemblies
10. Uninterrupted operation
11. Moisture-resistant
12. Create savings

"Carboloy" is the trademark for the products of Carboloy Department of General Electric Company

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2. SPACE-SAVING, 1½" dia. x 4½" high.
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6. SHOCK-MOUNTED on Silicone rubber.
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Also, manufacturers of frequency standards, multi-frequency standards, chart-recording chronographs, firing-cycle timers, the Watch-Master Watch Rate Recorder and other high-precision frequency and timing instruments, controlled by our tuning-fork oscillators.

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Gear this frequency standard to your designs and help solve climatic, space and weight problems in JAN-ized-MIL equipment

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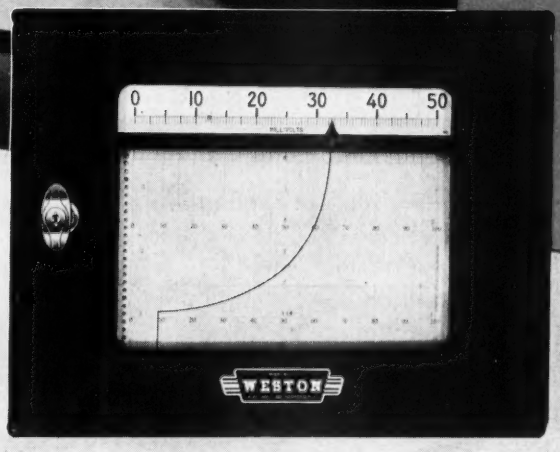
You change chart speeds this simple way



New! simplified... Recording Potentiometer by WESTON

Maybe you seldom change chart speeds . . . while other users frequently do. But should the need arise, isn't it best to have a *flexible* instrument . . . one quickly adaptable for any requirement that comes along?

As shown above, the change is simple and quick with the new WESTON Recording Potentiometer. No multiplicity of gears involved . . . no complicated gear changes to make. This speed linkage permits quick selection of 5 different speeds by simple screwdriver adjustment. And these speeds can be doubled or quadrupled by quickly changing only two gears.

This is just one of a dozen features that make this the simplest, most flexible recorder ever offered. Changing ranges, installing charts, removing amplifier . . . all are just as simple and quick! Combined, they cut maintenance 'way down. And for accuracy and dependability . . . they're assured by the name the instrument bears.

For full details, ask your local WESTON Representative, or write . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Ave., Newark 5, N. J. . . . *manufacturers of Weston and Tag Instruments.*

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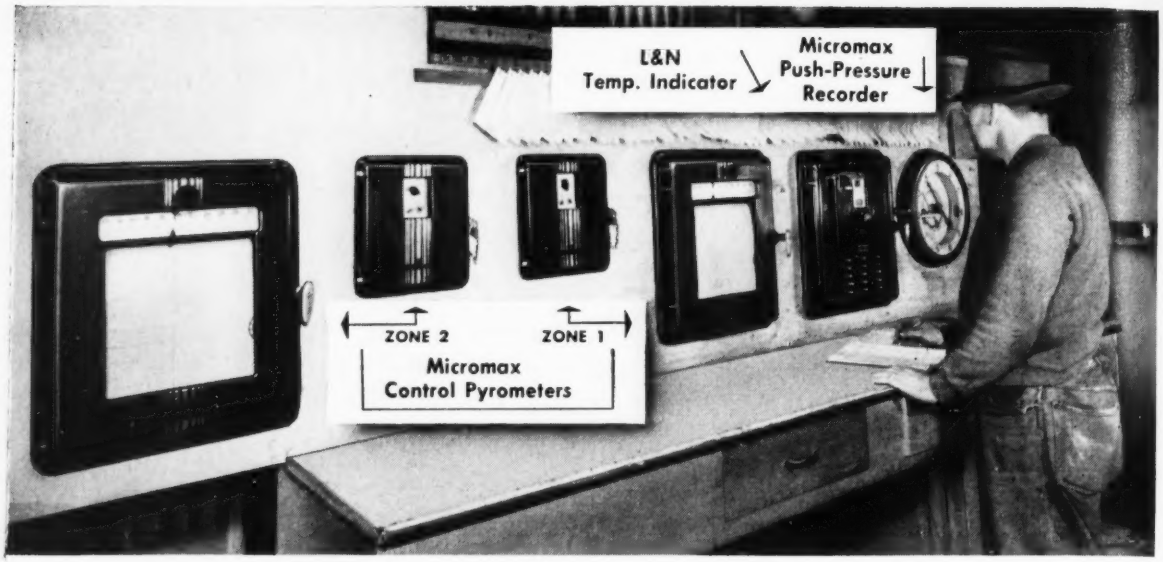
9130 **WESTON** *Instruments* INDICATE — RECORD — CONTROL



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You can control temperature as you wish, and get dependable, continuous facts, by using MICROMAX INSTRUMENTS

• Gladding, McBean & Co., big West Coast producers of a great variety of clay products, says that their Micromax instruments are "definitely related to the attainment of high-quality product and reduction of rejects to a minimum."

This firm uses many instruments, and uses them in many ways; typical applications are in their Los Angeles brick and tile plant. Here, L&N instruments help on two problems: First, to be sure the cars of ware are pushed through the kiln at proper speed. Second, to preheat, fire and cool at proper temperatures.

In car pushing, a Micromax Recorder shows the pressure in the hydraulic push system. By recording pressure against time, this instrument also shows rate of loading and speed of cars.

In temperature control, two Micromax Controllers and one Indicator are used per kiln. Controllers throttle the fuel supply up and down in strict proportion to changes, whether the firing is proceeding normally or whether some operating condition has arisen to compel more strenuous action. The Indicator provides for manual checks at any time of any thermocouple point in either firing, preheating or cooling. Between them, the various L&N instruments put the kiln operator in complete command of temperature.

To get full benefit from the options which are yours in L&N equipment, we suggest you contact us, either at our nearest office or at 4955 Stenton Ave., Philadelphia 44, Pa.

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Jrl Ad N-664(2)

Puts new light on "visibility"

—the crystal clear plastic front with clean, rounded edges floods the scale with unobstructed natural light. The dial sets well up into the translucent cover, permitting full natural lighting from the top, sides and bottom. (No bezel or case rim interrupts light from any angle.)

—Another advantage—the full, open dial on this new 3″ instrument gives much longer scale length than on conventional three-inch meters, yet the mounting and panel space is exactly the same.

—Your name or trademark can be shown with colorful emphasis.

Now—with competition getting keener—is a good time to improve your panels. Take a look at Model 321 PL soon.

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

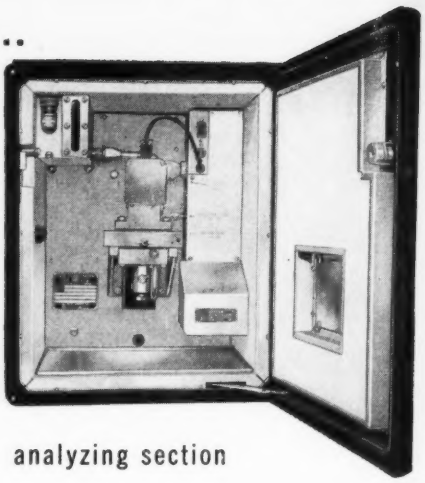
Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY · BLUFFTON, OHIO, U.S.A.

TRIPLETT ELECTRICAL INSTRUMENT CO., BLUFFTON, OHIO, U.S.A.
In Canada: Triplett Instruments of Canada, Georgetown, Ontario

for large industrial power plants and central stations...

a new CO_2 RECORDER using three established ideas



analyzing section

Designed to handle the CO_2 measurement problems of large industrial power plants and central stations the new *Hays Condu-Therm CO_2 Recorder* uses three established ideas:

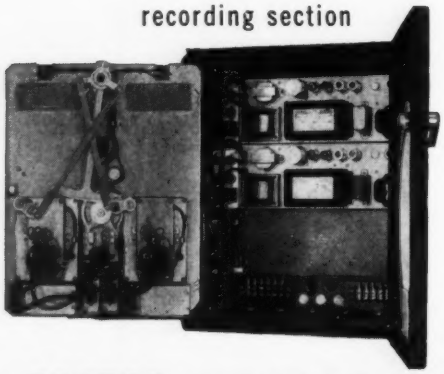
1. *The use of CO_2 measurement as a guide to combustion efficiency* . . . has been used by thousands of boiler plants and industrial furnaces, particularly where a single fuel such as natural gas, oil, bituminous or anthracite coal is being burned.

2. *The thermal conductivity principle of gas analysis* . . . has been accepted extensively in the process industries, because of its fast response to changes in gas composition, its freedom from chemicals, and its proven reliability.

3. *Electronic type operation* . . . frees the instrument of the step action and delicate construction commonly found in galvanometer operated instruments . . . also adds greater speed, power and magnification, while assuring high accuracy and permanency of calibration.

features five second response with ±.25% accuracy

recording section



the condu-therm features:

- ***5 second response to CO_2 change due to:***

  rapid change of sample gas in gas passage system

  small volume of gas in analyzing cell

  continuous connection (through amplifier) between analyzer and recording pen motor

- ***±.25% accuracy for chart ranges up to 0 to 20% due to:***

  slide wire construction . . . 5 tolerances held to .1%

  recording pen cam precision-machined to .0001 in.

  high power gain (2.5 million)

- ***"Boiler plant" construction unavailable in any other instrument:***

  linkage of ⅛" x ½" bar

  multiple pen bearing of telescoping stainless steel tubes

  oilite bearings do not require lubrication

  chart plate of ¼ in. permanent mold casting

  unit construction for easy replacement of each main element

For full information on the Hays Condu-Therm CO_2 Recorder write for Bulletin 51-1008 which includes:

detailed explanation of operation of analyzing and recording sections

completely illustrated discussion of component parts and features

drawings of and information on gas sampling systems.

THE **HAYS** CORPORATION

MICHIGAN CITY 8, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

THE SOLA FAMILY OF *5 Voltage Regulator Types*

MEETS MOST MILITARY and INDUSTRIAL REQUIREMENTS

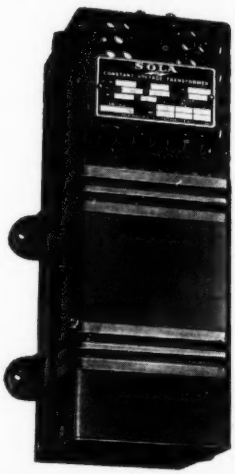
SOLA DISCIPLINES VOLTAGE

SOLA adjustable, harmonic filtered type CVL:

Regulation ±1%
Harmonic Distortion less than 3%
Output adjustable from 0-130 volts

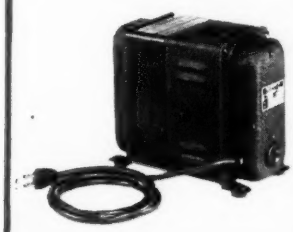
SOLA standard type CV:

Regulation ±1%



SOLA television receiver type CVA:

Regulation ±3%
Plug-in accessory unit



SOLA plate and filament type CVE:

Regulation ±3%

SOLA harmonic filtered type CVH:

Regulation ±1%
Harmonic Distortion less than 3%

CHARACTERISTICS OF SOLA CONSTANT VOLTAGE TRANSFORMERS

- Static-magnetic regulation
- Ultra-fast response (1.5 cycles)
- No moving or renewable parts
- No manual adjustments
- Complete automatic, continuous regulation
- Self-protecting against short circuits
- Automatic current limiting action
- Choice of transformation ratios

We invite you to write regarding your voltage regulating problems, or for inclusion of your name on our technical mailing list.

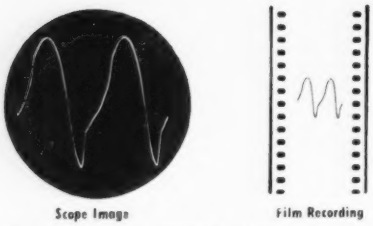
SOLA *Constant Voltage* TRANSFORMERS

Made under one or more of the following patents: 2,143,745; 2,212,198; 2,346,621; 2,552,111; 2,489,245 and patents pending.

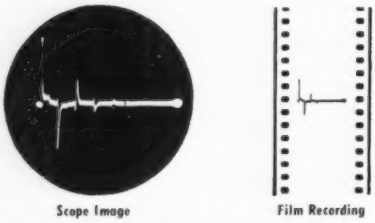
Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Airport Lighting • Series Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois

Manufactured under license by: ADVANCE COMPONENTS LTD., Walthamstow, E., England • M. C. B. & VERITABLE ALTER, Courbevoie (Seine), France ENDURANCE ELECTRIC CO., Concord West, N. S. W., Australia • UCOA RADIO S.A., Buenos Aires, Argentina

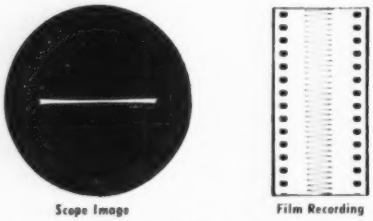
Want an oscilloscope camera NOW?



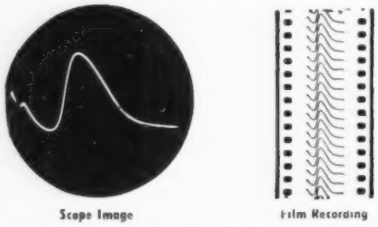
1. Single-frame photography of stationary patterns using a continuously running sweep.



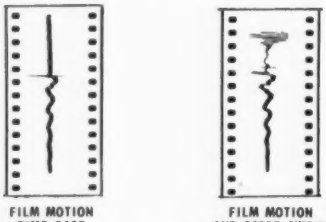
2. Single-frame photography of single transients using a single sweep.



3. Continuous-motion photography employing film motion as a time base.



4. Continuous-motion photography employing oscilloscope sweep as a time base.



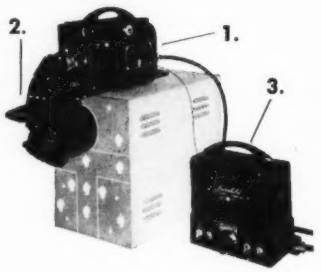
5. Continuous-motion photography employing combination of film motion and oscilloscope sweep as a time base.

Fairchild Oscillo-Record Cameras are now available *from stock* for immediate shipment. With these units you can make *permanent* photographic records of oscilloscope traces, thereby eliminating possible errors in making hand sketches from memory. In time-saving and convenience alone, these cameras will pay for themselves many times over.

FAIRCHILD OSCILLO-RECORD CAMERA IS UNUSUALLY VERSATILE

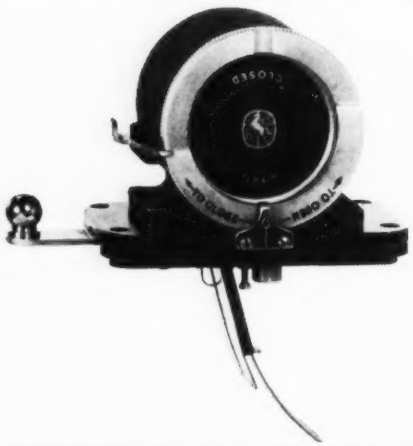
Users of the Fairchild Oscillo-Record Camera like its versatility. Designed for both still and continuous-motion photography on 35-mm film, it records non-recurring phenomena that are too rapid for visual study, others that are so slow that continuity is lost, and the occasions where very high-speed transients are combined with very slow-speed phenomena. For some idea of the types of jobs this instrument can do, study the examples at the left. Each solves a particular problem. Oscillo-Record camera users especially like its:

- **CONTINUOUSLY VARIABLE SPEED CONTROL**—1 in/min. to 3600 in/min.
- **TOP OF SCOPE MOUNTING** that leaves controls easily accessible.
- **PROVISION FOR 3 FILM LENGTHS**—100, 400 or 1,000 feet.



1. Camera, 2. periscope, 3. electronic speed control. Accessories include 400- and 1,000-ft. film magazines, magazine adaptor and motor, universal mount for camera and periscope, binocular split-beam viewer.

FAIRCHILD TAKE-UP CASSETTE FOR SHORT RUNS



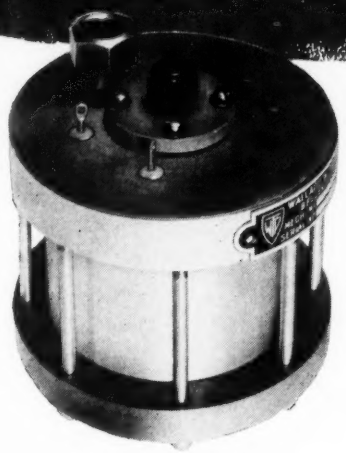
Where only a few pictures are required for quick development and study, a small Take-up Cassette is available as an accessory. The convenience afforded by this unit results in the saving of considerable time in handling short runs and reduces film wastage to a minimum. It is easily attached to the top of the camera by means of an adapter. A built-in knife permits short lengths of exposed film (up to 10 feet) to be cut off and removed with the cassette for developing.

Complete information about applications and operation of both the Fairchild Oscillo-Record Camera and the Fairchild-Polaroid Oscilloscope Camera is available. Write today to *Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, New York, Department 120-181 1.*

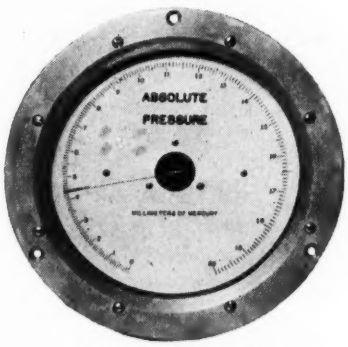
FAIRCHILD
OSCILLOSCOPE RECORDING CAMERAS

FOR DEEP VACUUM OPERATIONS

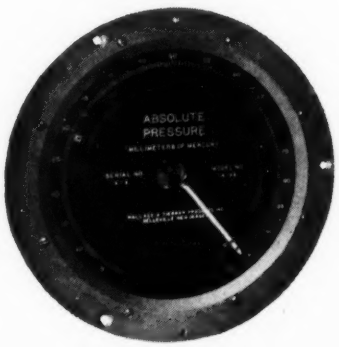
W&T PRECISION INSTRUMENTS



FA-193



FA-160 0-20 Scale



0-100 Scale

A-85

THE W&T ABSOLUTE PRESSURE CONTACTOR

This sensitive, yet durable aneroid device is used for actuating an electric circuit at a preset value of absolute pressure.

Outstanding features of the Contactor, type FA-193, include:

Range of adjustment	0-2 mm Hg. and other ranges made to customer's specifications up to 800 mm Hg. absolute pressure.
Sensitivity	will make or break within 0.10 mm Hg.
Contact capacity	5 ma at 115 volts A.C.
Repeatability	0.10 mm Hg.

Vacuum-tight construction
Over pressure protection

THE W&T ABSOLUTE PRESSURE INDICATOR

This precision instrument is used for quick, dependable indications of absolute pressures in the vacuum range. Pressure readings are independent of the nature of the gas. It is available in two dial sizes — 2¾" and 6".

Other features of the Indicator, type FA-160, include:

Range	0-20, 0-50, 0-100, 0-200, 0-410 and 390-800 mm Hg. absolute pressure.
Sensitivity	One part in 500
Accuracy	One part in 300

Over pressure protection
Direct readings
Rugged vacuum-tight construction

THE W&T ABSOLUTE PRESSURE CONTROLLER

The Controller with its associated Electronic Relay furnishes precision control of absolute pressure and provides a continuous indication of absolute pressure. Independent adjustment of the "high" and "low" contacts is made through a magnetic clutch thus eliminating stuffing boxes and seals and ensuring leak-tight operations.

Outstanding features of the Controller include:

Range	0-20, 0-50, 0-100, 0-200, 0-410 and 390-800 mm Hg. absolute pressure.
Sensitivity	One part in 500
Accuracy	One part in 300
Relay contact capacity	5 amps, 110 Volts, 60 cycles non inductive load.

Fast accurate response
Over pressure protection
Vacuum-tight construction

Additional Information Will Be Supplied On Request

WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
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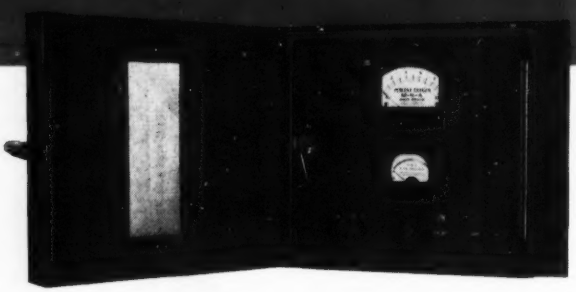
The M·S·A **INFRA-RED GAS AND LIQUID ANALYZER** (IIRA TYPE)

FOR:
- ★ Rapid automatic analysis of fluid mixtures
- ★ Measuring toxic contaminants in atmospheres
- ★ Precise process control

This accurate, sensitive instrument, designed primarily for use in industrial plants, has application in any process involving infra-red absorbing gases or liquids. Completely automatic, the M.S.A. Infra-Red Gas and Liquid Analyzer makes a continuous and rapid analysis for one component of a sample mixture. It has been successfully used in solving a wide variety of production, control and research problems. Our bulletin gives complete details on operation, selective analysis techniques, sensitivity, construction, and application. Write for your copy today.



The M·S·A
OXYGEN INDICATOR
(TYPE C-2)

FOR: ★ **Continuous, precise measurement of the oxygen content of gaseous mixtures**

Compact and accurate, this device fills many industrial needs. It measures the oxygen content of inert and combustible atmospheres in chemical, metallurgical and petroleum operations. It checks oxygen content of fuel gases for improved safety in utilities, and aids in the control of pipe line corrosion. By measuring combustion efficiency, it helps to save on fuel costs. Can be supplied completely assembled and wired with steel panel and base. Write for complete details.

OTHER M. S. A. INSTRUMENTS FOR THE DETECTION OF COMBUSTIBLE AND TOXIC GASES, AND DUSTS . . . Explosimeter—Carbon Monoxide Tester—Combustible Gas Alarms, Indicators—Benzol Indicators—Methane Detectors—Carbon Monoxide Alarms, Detectors—Aromatic Hydrocarbon Detector—Hydrogen Sulfide Detector—Midget Impinger—Electrostatic Sampler—Samplair—Microprojector.

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NATIONAL INSTRUMENT CONFERENCE AND EXHIBIT—CLEVELAND, OHIO
SEPTEMBER 8 TO 12
We'll have our complete instrument line in
BOOTHS 301 and 303

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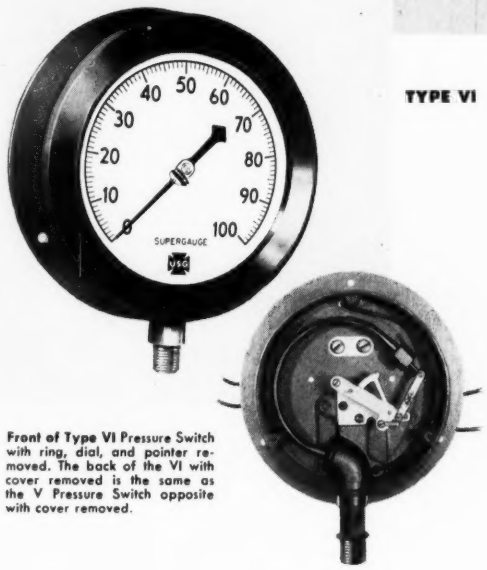
At Your Service

Call the M.S.A. men on your every safety problem . . . his job is to help you

PRESSURE SWITCHES

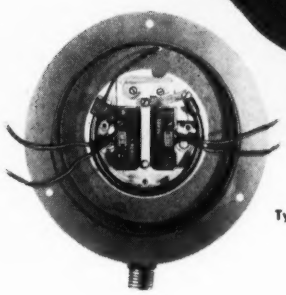
• What they are • How they work • Where you use them



TYPE VI

Front of Type VI Pressure Switch with ring, dial, and pointer removed. The back of the VI with cover removed is the same as the V Pressure Switch opposite with cover removed.

TYPE V



Type V Pressure Switch with cover removed.

The USG Type V Pressure Switch consists essentially of a pair of micro-switches making or breaking contact in response to a pressure-sensitive element (bourdon spring).

Type VI has the same switch-operating pressure element as Type V but it has an additional bourdon spring connected to a pointer so that pressure can be read on a dial.

Pressure switches are used wherever a pressure warning signal must be given. Typical applications are: hydraulic pumps, hydraulic presses, die casting equipment, or guarding or controlling high or low tank pressures.

For information relating to your problem, call the United States Gauge office in your city or get in touch with us at Sellersville. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

CONSTRUCTION

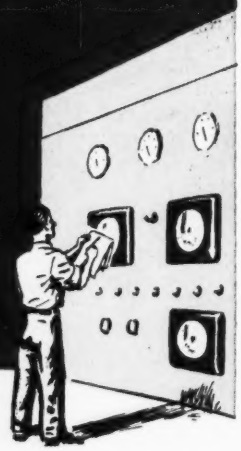
TYPE V	**Case:**	Cast-iron case, back flange mounting, black crackle finish.
	Size:	4½" case only
	Bourdon Tube:	Beryllium copper or stainless steel
	Pressure Connection:	Lower only: ¼" male N.P.T. up to 1000 lbs. pressure; ½" male N.P.T. for 1000 lbs. and over.
	Electrical Connection:	½" female pipe conduit.
	Pressure Ranges:	Up to 10,000 p.s.i., vacuum to 30".
	Micro-switches:	High and low; rated 10 amps., 110 A.C., both fully adjustable over entire range of gauge.
	Switching Differential:	3%. Switches are not affected by overpressure.
TYPE VI		Same case construction, micro-switches, switch-operating elements, switching differential, pressure connections, electrical connections, and pressure ranges as Type V.
		Case has dividing wall between the separate bourdon spring systems for operating the pointer and the micro-switches.
	Dial Sizes:	4½" and 6"
	Accuracy of Indications:	½ of 1% of the scale range.

Quality Gauges Engineered for Enduring Accuracy UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS

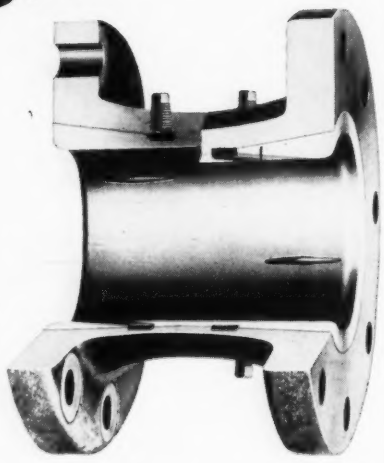
YOU CAN MEASURE FLOW WITH GREATER ACCURACY AND LESS HEAD LOSS



with the

FLOW TUBE

(Gentile Patents)



To insure maximum combined accuracy of primary element and receiver, each Flow Tube is furnished with an individual head capacity curve (Flow Tube discharge coefficients cannot be obtained by calculations). For unusual piping arrangements, calibration test curves for simulated conditions are furnished.

To keep pumping costs at a minimum, the Flow Tube is made in four principal types for various media and main line velocities. This makes it possible to select the one best suited to the medium and the velocity of the flow, so that the differential produced is accurately measurable with the least pressure loss.

When you also consider the fact that the Flow Tube is so much easier to handle and install, because it is so much shorter and weighs so much less than the conventional venturi, it is clear why it is being increasingly used in a wide range of services. For further information on the Flow Tube, ask for Bulletin FT-101; and if you would like specific recommendations, please give us the processing and installation details of your metering requirements.

FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . CUSHION CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SIRENS . . . SAFETY VALVES . . . FLOW TUBES

below 800° F.

Accurate

TEMPERATURE READINGS

in a few seconds . . .

XACTEMP

Low Temperature - General Purpose

HAND PYROMETER

Type LT-840
Low temperature Xactemp Pyrometer with rigid extension arm and surface tip thermocouple.

1001 USES

This is the answer to quick, accurate temperature readings below 800° F. in many industrial processes and operations. And it's so convenient to handle.

The Xactemp hand-type pyrometer, Model LT-840, is used with needle thermocouples, ribbon thermocouple, surface tip thermocouple, and other specially designed thermocouples and extension arms. These are easily interchangeable and, without adjustments or recalibration of the instrument, quickly ready it for measuring the surface temperature of stationary and revolving rolls and cylinders, flat and irregular surfaces of molds, dies, etc. in rubber and paper making, plastic materials, rubber, wax, oils, greases, and other semifluid materials.

Handy, compact design makes this Xactemp pyrometer ideal for field service, laboratory, and production-line use.

Price *Xactemp Pyrometer less thermocouples* $51.50

Write for detailed, descriptive literature on Gordon Xactemp Pyrometers.

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engineered simplicity

capacilog STRIP CHART recorder

instantaneous "no contact" controlling

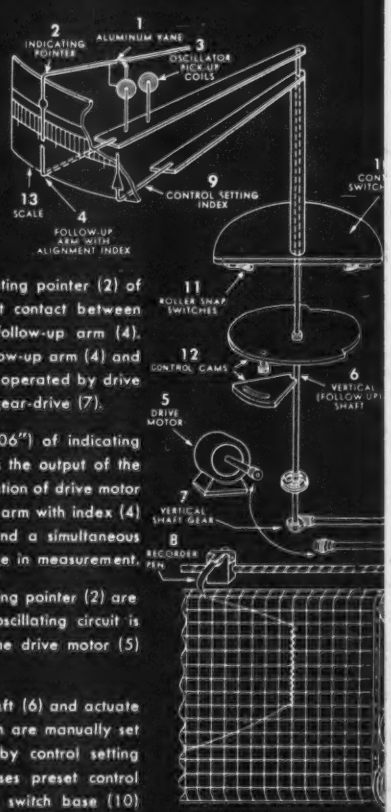
Single Point Electronic Strip Chart Recorder-Controller

gineered simplicity gives operating accuracy and chanical stamina to Capacilog Recorder-Controllers.

mination of mechanical clamping mechanism between dicating pointer and control unit allows instantaneous cording action. Design simplicity confines moving parts a minimum; maintenance is easy, mechanical wear is gligible. An added convenience is the plug-in chassis r facilitating quick replacement or change-over.

apacilog strip chart Recorders are available with ther high or low temperature measuring systems for ectrical or pneumatic control. Write for Bulletin C2-2.

diagram of operation



The aluminum vane (1) mounted on indicating pointer (2) of measuring system is free to pass without contact between the oscillator coils (3) mounted on the follow-up arm (4). An Alignment Index is mounted on this follow-up arm (4) and is coupled to scriber mechanism which is operated by drive motor (5) through vertical shaft (6) and gear-drive (7).

An imperceptible deviation (.004" to .006") of indicating pointer (2) with respect to coils (3) alters the output of the oscillating circuit causing instantaneous rotation of drive motor (5) in proper direction to move follow-up arm with index (4) to coincide with indicating pointer (2), and a simultaneous movement of pen (8) to record the change in measurement.

When the Alignment Index (4) and indicating pointer (2) are in exact coincidence, the output of the oscillating circuit is balanced with the supply voltage, and the drive motor (5) does not rotate.

Control cams (12) rotate with vertical shaft (6) and actuate roller type snap action switches (11) which are manually set at the selected control level indicated by control setting index (9). When indicating pointer crosses preset control level, control action takes place. Control switch base (10) will accommodate a maximum of four roller type switches.

See us at booth 310-312 Instruments Show — Cleveland

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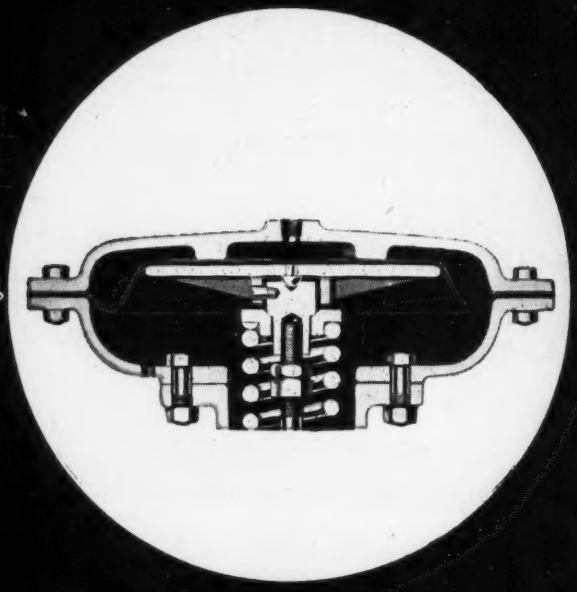
BARBER-COLMAN COMPANY • ROCKFORD, ILLINOIS, U. S. A.

1219 ROCK STREET



ROLLING ACTION . . .

for superior spring-diaphragm characteristics

The pre-moulded neoprene diaphragm in the Honeywell Series 700 Valve features rolling action . . . eliminates wrinkling or buckling . . . responds to slightest change in signal air pressure . . . may be used with either air or gas as actuating medium. The Honeywell Series 700 Valve is available in a wide range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-3.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1908 Windrim Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
VALVE PRODUCTS
First in Controls

H HONEYWELL

INSTRUMENTS FOR LABORATORIES

Thermocouple Potentiometer Used to Check Jet Engine Performance and Controls

At the U.S. Air Force's Edwards Base, Muroc, California, a Type PJ-1 thermocouple potentiometer is being used to check the performance of the G-E J-47 jet engines in the F-86D Sabrejet, and the B-47B, Stratojet.

In addition to this application the PJ-1 can be used in the laboratory to measure heat-runs on motors, or for refrigerator development work, oil burner and air-conditioner tests, and oven and furnace temperature surveys.

WIDE VARIETY OF RANGES

The PJ-1 has three millivolt ranges, 0-6, 0-30, and 0-60 mv and a variety of temperature scales can be supplied for measurement from below zero to 2500 F. The PJ-1 can be used by inexperienced personnel, since there is no standard cell and temperatures can therefore be read directly in degrees F or C.

HIGHLY ACCURATE

Accuracy of the PJ-1 is ±.2% of full scale. Price is $198.90* in standard 0-6 millivolt ranges. A portable 10-point transfer switch is also available. For more information check coupon at right.

Quick Detection of Pipeline Corrosion With Type CE Photoelectric Recorder

The East Bay Municipal Utility District, Oakland, California, has found the General Electric Type CE photoelectric recorder a vital aid in the fight against water pipe line corrosion. Mr. Fred Terry, East Bay Corrosion Engineer, reported "We have found that this recorder provides the most satisfactory method of determining just where corrosion exists."

94 MILES OF PIPE SURVEYED

The recorder was used to make electrolysis surveys of a 94-mile stretch of pipe. Each section surveyed was from 1500 to 3000 feet long and contained concrete structures with manholes through which wires could be attached to the pipe. Wherever a drop in current was found, corrosion was indicated.

HIGH-SPEED RESPONSE

Because of the recorder's high response speed, East Bay was able to measure accurately when the current recorded was rapidly fluctuating. They found it was not necessary to constantly balance the recorder in the field.

MANY MODELS AVAILABLE

Standard CE recorders are available with sensitivities from 1 to 5 ma. or from .2 to 500 mv. Higher values can be measured with special recorders which have suitable resistors or shunts added. Non-electrical quantities can be recorded by using external primary detectors. Chart speeds range from ½ inch per hour to 72 inches per minute; response periods as fast as ⅕ second for full-scale deflection.

Low Cost Oscillograph Aids Development Test

OSCILLOGRAMS IN ONE MINUTE was the answer recently when a large electrical manufacturer found it necessary to make some rapid development tests on a new type relay. The General Electric PM-18 oscillograph equipped with a Polaroid-Land film holder enabled the manufacturer to obtain permanent records of each test one minute after test and to complete an entire series of 8 tests in one hour.

Designed to record 2, 3, or 4 currents or voltages simultaneously, the PM-18 can be used for sine wave frequencies up to 500 cycles per second with its Polaroid-Land film holder, and up to 2000 cycles per second with the continuous-drive film-holder attachment. The PM-18 with Polaroid-Land film holder and 2 galvanometers costs only $740.57.* For more information check coupon below.

*Mfg.'s suggested retail price

SECTION C605-20, GENERAL ELECTRIC
SCHENECTADY 5, N. Y.

Please send me the following bulletins:
Indicate:
√ for reference only
× for planning an immediate project

- ☐ CE Photoelectric Recorder GEC-254
- ☐ PM-18 Oscillograph GEC-580
- ☐ Thermocouple Potentiometer GEC-245
- ☐ 1952 Measuring Equip. Cat. GEC-1016

NAME.....
COMPANY.....
STREET.....
CITY.....ZONE...STATE.....

GENERAL ELECTRIC

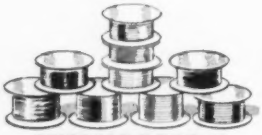
Industrial
PYROMETER & SUPPLY

WORLD'S LARGEST MANUFACTURER

PYROMETER & THERMOCOUPLE
EXTENSION LEAD WIRE

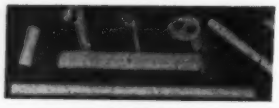
PYROMETER ENGINEERS, MAINTENANCE MEN, BUYERS, PLANT EXECUTIVES, Visit our Booth No.'s 411-413 and receive an invitation for an enjoyable evening.

WIRES

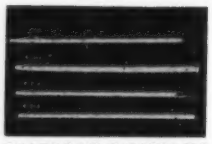


THERMOCOUPLE

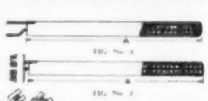
HEADS
INSULATORS



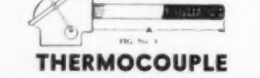
TUBES



THERMOCOUPLES



THERMOCOUPLE
LEAD WIRES



INDUSTRIAL PYROMETER AND SUPPLY Co. ALTON, ILL. U.S.A.

You and your associates
(bring the ladies)
are cordially invited to visit
us in the Grand Ballroom
Hotel Carter, Cleveland
from 9 p.m. til?
Monday, Tuesday, and Thursday
September 8th, 9th, and 11th, 1952

Refreshments—Bar—Dancing
Entertainment

Your Hosts:

Avery Hack *Frank Hack*
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INDUSTRIAL PYROMETER & SUPPLY CO.
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See our Booth Numbers 411 and 413
at the Exhibit
Please present this invitation at entrance.

WE OPERATE OUR OWN WIRE INSULATING MILLS
Large supply contracts our specialty. Aircraft temperature wires and cables.

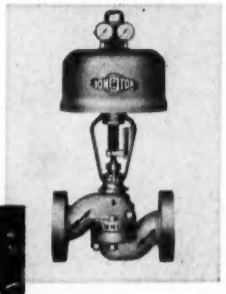
INDUSTRIAL PYROMETER AND SUPPLY Co. ALTON, ILL. U.S.A.

INDUSTRIAL PYROMETER AND SUPPLY COMPANY
ALTON, ILLINOIS

Cut CONTROL VALVE MAINTENANCE COSTS!

For inspection and maintenance Annin Valves remain in the line

The single seat design of the Annin valve body means lower maintenance costs. As shown, the lower half separates from the valve assembly, exposing for inspection or replacement the valve seat, plug and stem—without removing valve from line. No special pipeline crews are necessary. On-the-job inspection and maintenance by plant crews is practical and economical. Valve seat is not threaded and can be replaced without special tools or grinding-in operations. Under severe erosive and corrosive conditions lower half can be easily replaced at small cost compared to total valve investment. This cost-cutting feature applies to *all* Annin Valves—Domotor, Solenoid, and Handwheel types. All give the ultimate in precision *positive* control. If you are interested in lower maintenance, *and* operating advantages approached by *no other valve*—it will pay you to investigate Annin Valves.



The Annin Domotor valves provide positive control of corrosive, erosive fluids and fluids containing semi-solids.

Send for Annin General Catalog 1500B. Explains the exclusive Annin positive control Domotor action. Contains valuable cost-cutting hints, control valve application facts, flow formulas.

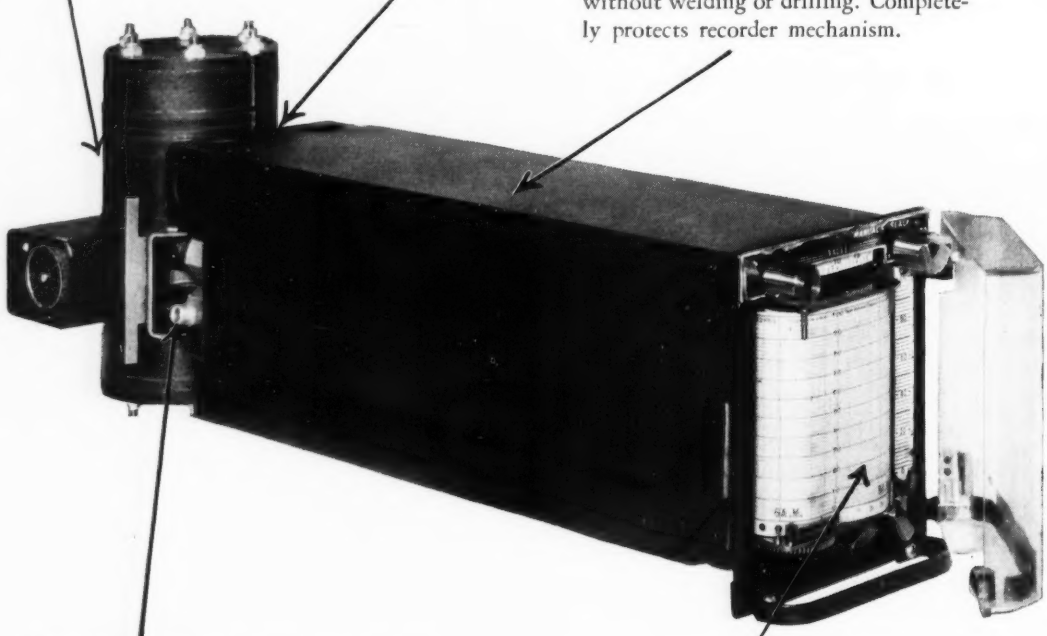
ANNIN CONTROL VALVES

PLUG IN

The plug-in controllers can be removed and replaced with another unit in just 10 seconds.

One common, self-sealing manifold gives plug-in connections to both receivers and controllers!

Rugged steel sleeve clamps on panel, without welding or drilling. Completely protects recorder mechanism.



The only piping on the panel back are lines from the transmitter, air supply and controller output. Units can be mounted just a few inches apart.

Recorder or indicator plugs in from the front—units can be interchanged in just 10 seconds.

THE NEW IDEA IN PANEL INSTRUMENTATION

Taylor, pioneer in the 3-part control system brings many new refinements based on extensive field experience

1. Change from simplest to most complex control by simply pulling out one unit, plugging in another.

2. Change from indicator to recorder or vice versa in only 10 seconds.

3. One mounting for both controller and receiver—recorder or indicator.

4. Recorders or indicators can be mounted on the panel without welding, without drilling holes.

5. Only piping connections required are air supply, controller output, and to variable transmitter. All other connections made automatically in self-sealing manifold.

6. All adjustments can be reached without disturbing any connections.

7. Mountings are extremely simple and rugged.

8. You save panel space by mounting units a few inches apart.

9. Receiver mechanism totally enclosed by protective sleeve.

10. You save money on installation—thanks to simplified piping and mounting.

Be sure to get information on the new and greater plug-in type Taylor TRANSET Control before you make any decision involving pneumatic transmission control. Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

▼ ▼ ▼

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

® Reg. U. S. Pat. Off.

ADDITIONAL NEW FEATURES IN TAYLOR'S TRANSET® RECORDER:

Continuous valve position indication on separate scale tells valve pressure at a glance.

Chart read back device gives easy access to past records without disturbing any function of the recorder or interrupting the record.

New chart drive mechanism for greater convenience, greater dependability.

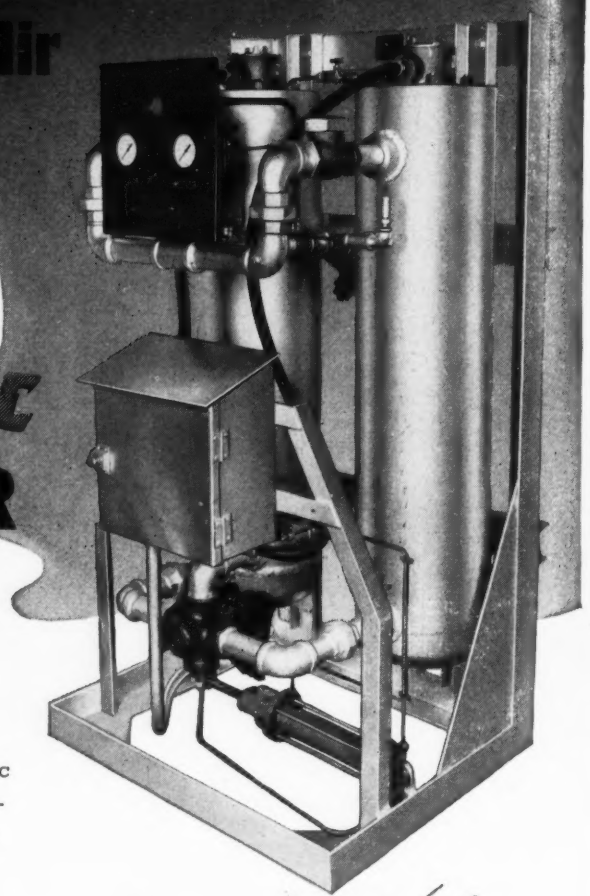
Taylor Instruments

MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

Keep Instrument Air CLEAN and DRY with an Industrol DYNAMIC DEHUMIDIFIER



With the widespread use of air operated instruments, it has become increasingly important that the supply of air to such instruments be clean and dry, free from oil and water vapors.

Backed by years of experience, INDUSTROL Dynamic Dehumidifiers have been especially designed to provide clean, dry instrument air, at low cost. With their use a drastic reduction of instrument maintenance is made possible. Costly instruments can last longer, operate at maximum efficiency.

Perfect heat distribution built into the design of these units assures excellent regeneration. To care for future needs, units are so designed that larger chambers can be installed with minimum effort and expense, should unit capacity need to be increased.

INDUSTROL Dehumidifiers are your answer for that day-in, day-out dependable instrument operation. Investigate today.

See the INDUSTROL Dehumidifier on display at Booths 610-612 7th National Instrument Exposition Cleveland Public Auditorium Cleveland, Ohio September 8 - 12

SEND FOR _____

new illustrated Bulletin DD-140 describing INDUSTROL Dehumidifiers and how to size a unit to fit your requirements.

Industrol DYNAMIC Dehumidifiers

offer these advantages:

- **Simplicity of design**
- **Ease of installation**
- **Superior type of desiccant —easily replaced without dismantling unit**
- **Perfect regeneration —steam or electric**
- **Minimum maintenance**
- **Complete dependability**
- **Compact, economical, rugged**
- **Sizes—35 - 1500 cfm.**

2037

Industrol CORPORATION

SUBSIDIARY OF TRINITY EQUIPMENT CORPORATION
494 Westfield Ave., East • Roselle Park, New Jersey

Now!
Transient-free test voltages down to 0.01 cps!

Versatile, general purpose generator for subsonic and audio work! Continuously variable, 0.01 to 1,000 cps, 5 bands. High stability, distortion less than 1%. Radical new circuitry offers sine, square and triangular waves.

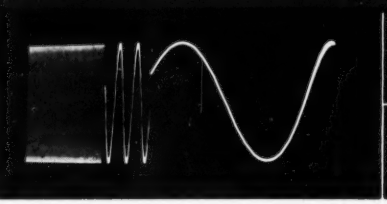


Figure 1. Oscillogram shows freedom from transients as output frequency is changed.

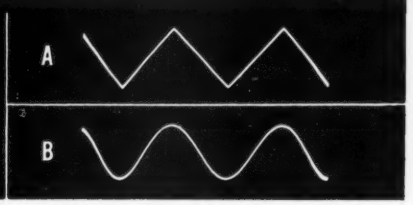


Figure 2. Oscillogram of (a) triangular wave applied to shaping circuit and (b) resulting sine wave.

SPECIFICATIONS

-hp- 202A Low Frequency Function Generator

FREQUENCY RANGE: 0.01 to 1,000 cps in five decade ranges.

DIAL ACCURACY: Within 2%.

FREQUENCY STABILITY: Within 1% including warm-up drift.

OUTPUT WAVEFORMS: Sinusoidal, square, and triangular.

MAXIMUM OUTPUT VOLTAGE: At least 30 volts peak-to-peak across rated load for all three waveforms.

DISTORTION: Less than 1% RMS distortion in sine wave output.

OUTPUT SYSTEM: Can be operated either balanced or single-ended. Output system is direct-coupled; dc level of output voltage remains stable over long periods of time. Adjustment available from front panel balances out of any dc.

FREQUENCY RESPONSE: Constant within 1 db.

HUM LEVEL: Less than 0.1% of maximum output.

SYNC PULSE: 5 volts peak, less than 10 μsec duration. Sync pulse occurs at crest of sine and triangular wave output.

POWER: 115-volt, 50/60 cycles, 175 watts.

DIMENSIONS: 10½" high, 19" wide, 13" deep.

PRICE: $450.00 f.o.b. Palo Alto, California. End frames, for table use, $5.00 per pair f.o.b. factory. (Specify No. 17.)

Data subject to change without notice.

–hp– 202A Low Frequency Function Generator offers you a compact, convenient and versatile source of transient-free test voltages between 1,000 and 0.01 cps. It provides virtually distortion-free signals for vibration studies, servo applications, medical and geophysical work, and other subsonic and audio problems. For such applications, the equipment generates 3 wave forms: sine, square and triangular. (Desired wave form is selected on front panel switch.) Output is 30 volts peak-to-peak for all 3 wave forms.

NEW CIRCUIT CONCEPT

–hp– 202A differs from conventional low-frequency oscillators in that the sine wave is electronically synthesized. A controlled bi-stable circuit generates a rectangular wave. This wave is passed through a special integrator providing a true triangular wave (Figure 2a). The triangular wave then enters a shaping circuit developed by *–hp–*. Here 6 duo-diodes modify or "shape" the peaks and provide a true sine wave with distortion of less than 1% (Figure 2b). This synthesizing circuit provides virtually transient-free output even when range switch is operated or frequency is rapidly varied. This circuit also maintains the amplitude constant under all conditions. It is not necessary to wait long periods for the circuit to stabilize at a new level as with conventional oscillators.

OTHER FEATURES

The output system of *–hp–* 202A is fully floating with respect to ground. May be used to supply a balanced voltage or either terminal may be grounded. It will deliver 10 v RMS to a load of 5,000 ohms or greater; internal impedance, however, is only 100 ohms. There are no coupling capacitors in the output system, and a high degree of dc balance is achieved by means of a special circuit.

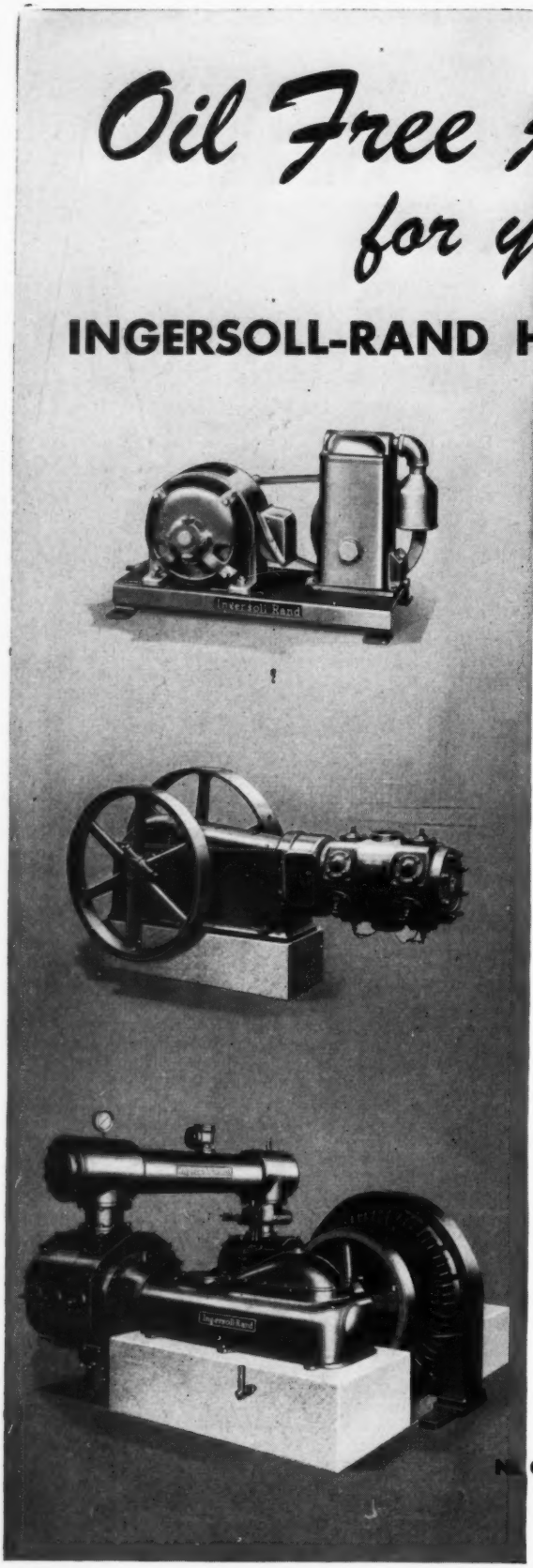
-hp- field engineers, in most major cities, have complete details. Or, write direct.

HEWLETT-PACKARD CO.
2325C Page Mill Road • Palo Alto, Calif.
Export: FRAZAR & HANSEN, LTD.
San Francisco • Los Angeles • New York

HEWLETT-PACKARD (hp) INSTRUMENTS

Oil Free Air for your Instruments

INGERSOLL-RAND HAS NL COMPRESSORS FROM THE SMALLEST TO THE LARGEST



Air-operated instruments, like production tools, are vitally important. That's why so many plants are using Ingersoll-Rand NL air compressors, that *don't pump oil*. This guards against instrument failures caused by oil-laden air.

Non-lubricated compressors, pioneered by I-R, feature pistons fitted with graphitic-carbon rings that prevent metallic contact of the piston with the cylinder bore. These carbon rings are segmental with metallic inner expanding rings, to give the proper wall pressure. Because metallic contact is eliminated, and the rings are self-lubricating, the Ingersoll-Rand NL Compressor cylinders require no lubricant.

To really put an end to production delays and excessive maintenance costs caused by oil-clogged instruments, get all the engineering facts and figures I-R makes available. Simply contact your nearest I-R representative, or write direct to Ingersoll-Rand, 11 Broadway, New York 4, New York.

Model N machines available through 1 hp.

Model 235 HNL machines available through 3 hp—other models through 250 hp.

Ingersoll-Rand

717-3

NL Compressors . . . 70 years of compressor "know-how" packed into these new compressors for air operated instruments!

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

MICROTORQUE*

Jewel Bearing

LOW TORQUE POTENTIOMETER

A Simple Solution to Remote Indicating

The Giannini Microtorque* is an extremely low torque, instrument-quality potentiometer with an electrical output proportional to the angular position of the shaft. Its compact, light-weight, rugged and dust-proof construction means flexibility in applications. It may be directly connected to altimeters, temperature and pressure instruments; used in automatic flight equipment or in industrial laboratory installations where remote indication is required.

The Microtorque* is designed to have an extremely low starting torque and a negligible operating torque. The low mass of the moving parts makes the Microtorque* useful in those applications where an extremely low moment of inertia is essential. The Microtorque* is a proven instrument with proven performance.

For information on this and other fine instruments write Dept. P. G. 1

Features

JEWEL BEARINGS

Jewel bearing construction offers watch-like precision, a high degree of shock resistance, and unusually low friction coefficient.

PLATINUM WINDINGS

The non-corrosive characteristic of platinum allows a light brush pressure to maintain efficient contact. This, in turn, virtually eliminates brush friction. Platinum, too, prolongs instrument life and assures dependability. One of the outstanding features that make the Microtorque* a truly low torque instrument-quality potentiometer.

SPECIFICATIONS

LINEARITY: ± 0.5% of total resistance.

MAXIMUM OPERATING SPEED: 100 rpm.

ACCELERATION: Will withstand 50G steady state acceleration in best axis.

VIBRATION: Will withstand 0.06" double amplitude sinusoidal vibration from 10 to 55 cps in best axis.

AMBIENT TEMPERATURE: Will function mechanically from −54° C. to + 71° C.

MOMENT OF INERTIA: 2 x 10−⁶oz-in.² (approx.)

TEMPERATURE COEFFICIENT OF RESISTANCE: .0006/° C. Max.

Following Microtorques* are available from stock in quantities of six or less:

RES. OHMS	STARTING TORQUE IN-OZ	TURNS OF WIRE TYPE 2	TYPE 9	CURRENT**	PRICE***
250	.006	350	450	57	$45.00
1,000	.004	500	650	28	$40.00
2,000	.004	700	750	20	$40.00
5,000	.003	900	1200	14	$40.00
10,000	.003	1,000	1300	10	$40.00
25,000	.003	1,000	1300	7	$45.00

**Must be de-rated for ambient temperature over 60° C.

***Prices apply to quantities of six or less. For quotation on larger quantities or special types, please write.

Above Microtorques* are available in the following two types:
Type 2: 270° + 10° − 0° Electrical Rotation, Mechanical Rotation. Limited by internal stops.

Type 9: 354° Min. Electrical Rotation, Mechanical Rotation. Continuous. Brush does not short ends of coil.

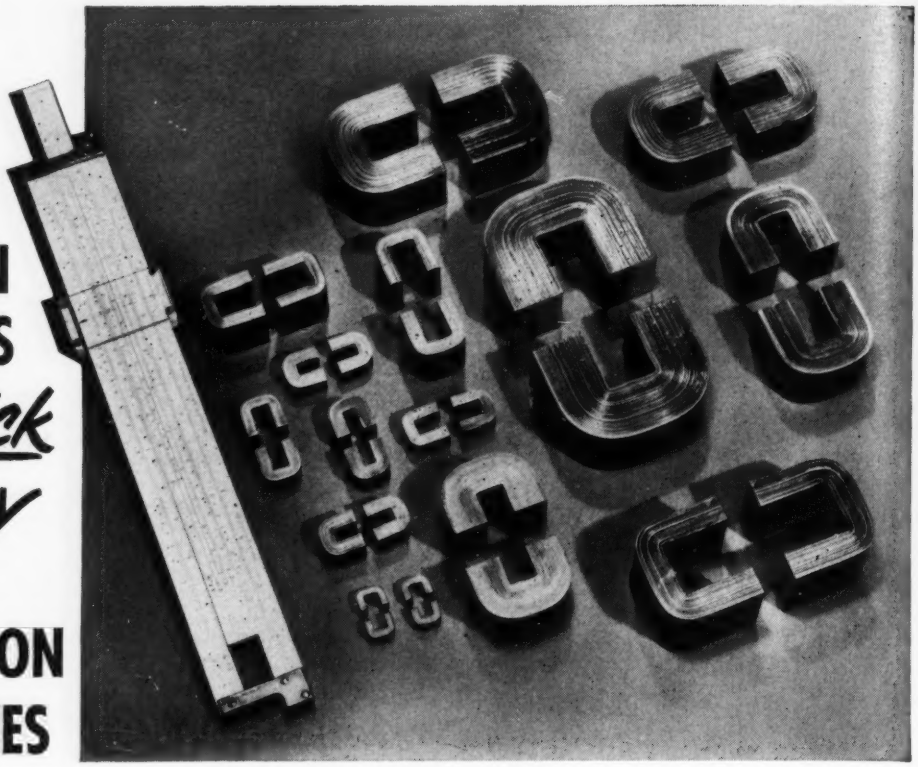
Giannini also produces potentiometers of various types, including non-linear functions, and tapped windings.

Giannini INSTRUMENT-QUALITY **POTENTIOMETERS**

*MICROTORQUE—*T.M. REG. 1952

G. M. GIANNINI & CO., INC. PASADENA 1, CALIF. EAST ORANGE, NEW JERSEY

SILECTRON "C" CORES *for quick delivery* IN PRODUCTION QUANTITIES



. . . wound from strip as thin as 0.00025"

Quality-Tested and Proved

- ★ Arnold "C" Cores are made to highly exacting standards of quality and uniformity. Physical dimensions are held to close tolerances, and each core is tested as follows:
- ★ 29-gauge Silectron cut cores are tested for watt loss and excitation volt-amperes at 60 cycles, at a peak flux density of 15 kg.
- ★ 4-mil cores are tested for watt loss and excitation volt-amperes at 400 cycles, at a peak flux density of 15 kg.
- ★ 2-mil cores are tested for pulse permeability at 2 microseconds, 400 pulses per second, at a peak flux density of 10 kg.
- ★ 1-mil cores are tested for pulse permeability at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gauss.
- ★ ½ and ¼-mil core tests by special arrangement with the customer.

Now available—"C" Cores made from Silectron (oriented silicon steel) thin-gauge strip to the highest standards of quality.

Arnold is now producing these cores in a full range of sizes wound from ¼, ½, 1, 2 and 4-mil strip, also 29-gauge strip, with the entire output scheduled for end use by the U. S. Government. The oriented silicon steel strip from which they are wound is made to a tolerance of plus nothing and minus mill tolerance, to assure designers and users of the lowest core losses and the highest quality in the respective gauges. Butt joints are accurately made to a high standard of precision, and careful processing of these joints eliminates short-circuiting of the laminations.

Cores with "RIBBED CONSTRUCTION"* can be supplied where desirable.

Ultra thin-gauge oriented silicon steel strip for Arnold "C" Cores is rolled in our own plant on our new micro-gauge 20-high Sendzimir cold-rolling mill. For the cores in current production, standard tests are conducted as noted in the box at left—and special electrical tests may be made to meet specific operating conditions.

● We invite your inquiries.

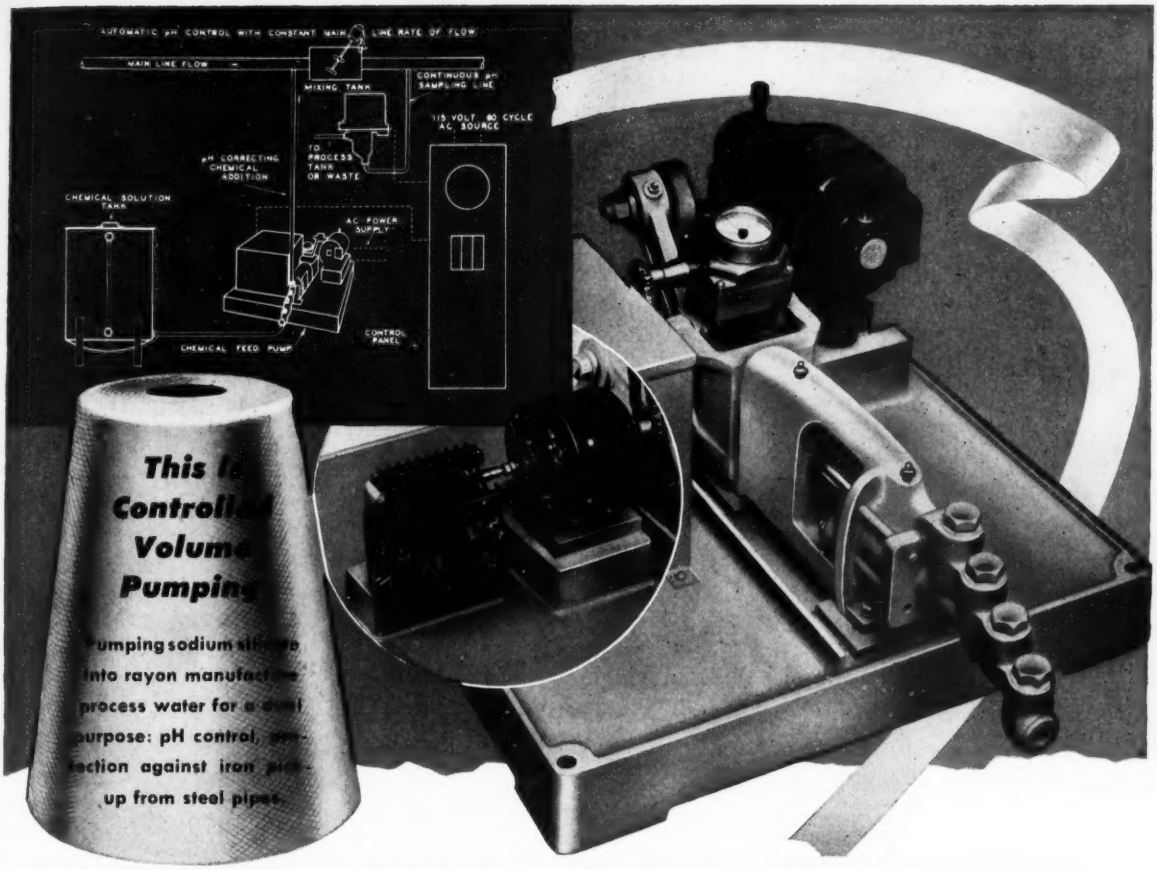
*Manufactured under license arrangements with Westinghouse Electric Corp.

W&D 4211

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois


AUTOMATIC pH CONTROL WITH CONSTANT MAIN LINE RATE OF FLOW
MAIN LINE FLOW
MIXING TANK
CONTINUOUS pH SAMPLING LINE
115 VOLT, 60 CYCLE A.C. SOURCE
pH CORRECTING CHEMICAL ADDITION
TO PROCESS TANK OR WASTE
CHEMICAL SOLUTION TANK
A.C. POWER SUPPLY
CHEMICAL FEED PUMP
CONTROL PANEL
This is Controlled Volume Pumping
Pumping sodium silicate into rayon manufacturing process water for a dual purpose: pH control, protection against iron pick-up from steel pipes.

THIS MILTON ROY AUTOMATIC pH CONTROL SYSTEM DOES THE JOB...

A large Eastern rayon manufacturer maintains precise pH control, guards against rayon discoloration by iron pick-up in process water by using a Milton Roy Automatic pH Control System. Sodium silicate is the control chemical. A predetermined pH control point insures a sufficient silicate feed to coat the inside of the pipes, preventing iron oxidation and subsequent iron pick-up. Field reports show this system pin-points pH value within safe limits of plus or minus 0.2 units, eliminates rayon discoloration, effects manufacturing dollar savings.

An important component of the Automatic pH Control System—which may be supplied with all accessory control equipment—is a Milton Roy Motor-Driven Simplex Controlled Volume Pump with motorized micro adjustment of pump plunger stroke length. Stroke length is controlled automatically from a pH controller to deliver sodium silicate continuously as required.

Protection against iron pick-up by the introduction of surface active and various corrosion inhibitors while maintaining precise pH control is just one application of the principle of Milton Roy Controlled Volume Pumping. Complete systems, utilizing the metering accuracy of Milton Roy Pumps—either motor-driven or air-powered—are employed in plants for pH control of flocculation in water purification; to maintain specific materials soluble or insoluble; to prevent unfavorable side reactions in organic synthesis; to promote greater adsorption of color bodies on resins or activated carbons, or for many applications in chemical processing. Accurate volume control may be maintained using two variables, such as rate of flow and pH value.

For detailed information, call the Milton Roy representative listed in your classified telephone directory. Or write us direct.

Manufacturing Engineers

WITH THE EXCLUSIVE STEP-VALVE DESIGN

MILTON Roy COMPANY

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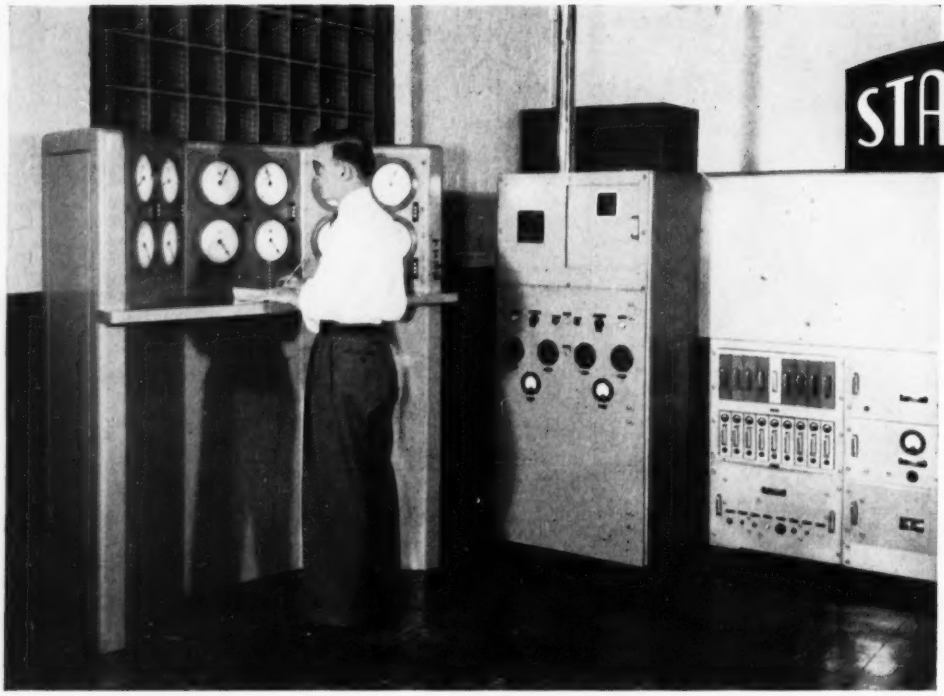
Instrument Show • Booth 401 & 403

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

Time and Time Again...



STANDARD
SINCE 1884

The Direct Reader shown was made by Baird Associates and includes Precision Timers by Standard.

STANDARD ELECTRIC TIME Helps Attain High Degree of Quality Control at AMERICAN BRASS

SPLITTING the split second is often essential . . . Hours, days are cut to a mere 300 seconds at The American Brass Company, Waterbury, Conn. . . . where this Direct Reading Spectrometer completely analyzes an electric furnace charge of molten metal before it is even poured.

THE STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

Money-saving helps for instrument makers!

THE BELLOWS ASSEMBLIES pictured here give you an idea of the many types we make—and we can give you more ideas that can make savings on *your* bellows assemblies requirements. For example, we will work with you to develop an assembly exactly suited to your needs. That's a specialty with us—has been for half-a-century. Then—our skilled personnel and ample facilities can relieve you of all production problems and worries. You save time, trouble and money.

If you need bellows assemblies for thermostatic devices . . . flexible connectors . . . expansion joints . . . pressure controls . . . hydraulic mechanisms or for other uses—we can help you. Write for helpful technical advice. Ask for idea-filled Catalog PE-1200.

FULTON SYLPHON
DIVISION
Knoxville 4, Tenn.

Robertshaw-Fulton
CONTROLS COMPANY
EVERYTHING'S UNDER CONTROL
TEMPERATURE CONTROLS • BELLOWS ASSEMBLIES • BELLOWS DEVICES

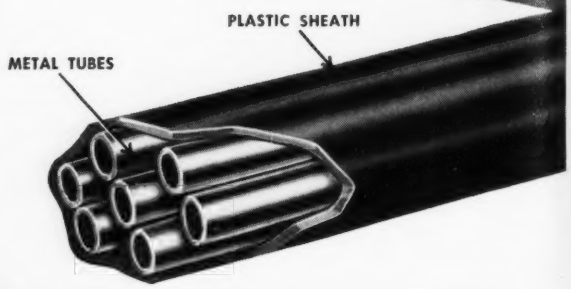
BRIDGEPORT THERMOSTAT
DIVISION
Bridgeport 1, Conn.

Announcing

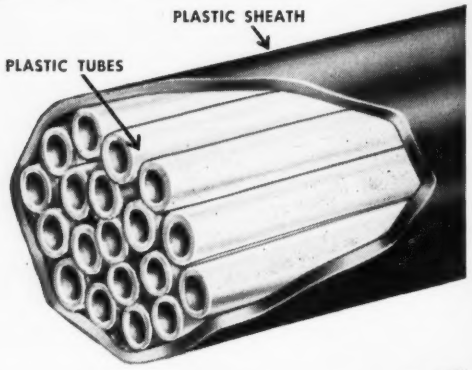
Dekoron Impervapak

THE CORROSION-PROOF

INSTRUMENT TUBING HARNESS



7 Tube Impervapak Metl-Cor



19 Tube Impervapak Poly-Cor

*Patent Applied For

Dekoron Impervapak* is an entirely new concept in instrument tubing that eliminates corrosion *once and for all.* It is available in two forms:

Impervapak Metl-Cor, in 50-foot lengths, is composed of a bundle of copper or aluminum tubes over which is extruded a 1/16 inch sheath of high molecular weight black polyethylene plastic. Bundles are formed of 4, 7 or 10 metal tubes of 1/4 or 3/8 inch OD. Other sizes to special order.

Impervapak Poly-Cor, supplied in coils of 500 to 1000 feet in length, is composed of a bundle of 4, 7, 10, 14 or 19 flexible polyethylene plastic tubes over which is extruded a black polyethylene sheath. Standard individual tube size is 1/4 inch OD with 1/8 inch bore; other sizes on special order. Individual tubes are color coded in blue, brown, black and natural for easy identification.

Dekoron Impervapak is the ideal solution to problems of corrosion. Moisture can't penetrate it . . . corrosive industrial atmospheres can't damage it. In addition to eliminating costly instrument tubing maintenance and replacement, Dekoron Impervapak has low initial cost . . . is easy to install.

Dekoron Impervapak literature is now in course of preparation. Meantime, free samples are available on request. Dekoron Impervapak will be displayed at Booth 331, Seventh National Instruments Exhibit, Cleveland, September 8-12th. A-5968

Dekoron tubing

SAMUEL MOORE & COMPANY

DEKORON TUBING DIVISION • MANTUA, OHIO

From the world's largest manufacturer of precision potentiometers . . . **Helipot**

come to **Helipot** *for the largest selection of* **multi-turn** *precision potentiometers*

advanced engineering! volume production!

HELIPOT is the organization that originated the helical potentiometer—the device that brought to electronic engineering new horizons of precise control by its greater resolution, higher linearity, mechanical precision, and broad range of resistance values. HELIPOT's policy of constantly working to anticipate the needs of the industry has led to steady advancement in the basic multi-turn principle—and today, HELIPOTS are available in the industry's widest selection of ranges and designs to meet varying requirements.

HELIPOT offers you . . .

▶ **Advanced Engineering.** Through its years of leadership HELIPOT has built an organization unequalled in the industry—with trained engineers, specially-designed equipment, overall facilities to solve *tough* potentiometer problems.

▶ **Volume Production of Special Designs.** HELIPOT not only welcomes tough potentiometer problems, but also has expanded facilities to mass-produce special designs to rigid specifications—at economical cost!

▶ **Versatile Basic Designs.** Most of the basic units shown below can be readily adapted to special requirements—ganged assemblies, servo mountings, single or double shaft extensions, taps spot-welded to a *single* turn of winding at virtually any desired point, and many other individualized features to meet *your particular needs!*

Illustrated below are typical basic models of Multi-Turn Helipots . . .

MODEL A:
A 10-turn unit, approximately 1¾" diameter with 12 to 14 times the resolution of single-turn units of same diameter. Very versatile—low in price—wide range of applications.*

MODEL C:
Similar to Model A, but 3 turns of resistance winding instead of 10.*

MODELS B, D, & E:
Larger-diameter (3 5/16") designs. B has 15 turns—D, 25 turns—E, 40 turns, for applications requiring extreme ranges of adjustment and highest possible resolution.*

ultra-precision

MODELS AN, BN, & CN:
Similar to Models A, B & C in size and performance but feature precision ball-bearings and extra-close tolerances throughout. Have approximately twice the linearity accuracy of equivalent standard Helipots—are ideal servo units.*

miniature

MODELS AJ, AJS, AJSP:
Tiny multi-turn Helipots the diameter of a penny, weight 1 oz. All have 18.5" slide wire for high resolution (1/6550—50 K unit). AJ has threaded bushings, sleeve bearings . . . AJS, servo mountings, sleeve bearings . . . AJSP, servo mountings, ball bearings. Many other features.*

THE Helipot CORPORATION
SOUTH PASADENA 11, CALIFORNIA

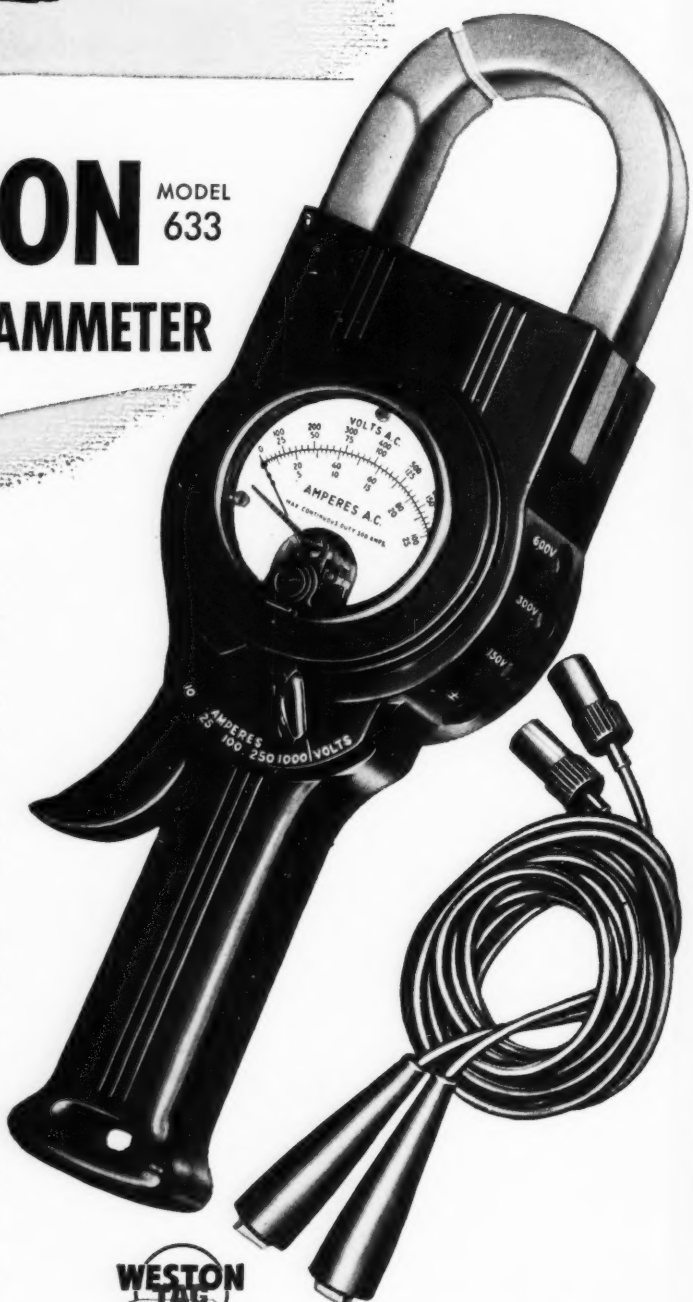
* See Your nearest Helipot Representative for complete details—or write direct!

Field Offices: Boston (CO. 7-1961), New York (Rockville Center 6-1014), Philadelphia (COllingswood 3-3515), Rochester (CU. 7440), Schenectady (DE. 2319), Cleveland (PR. 1552), Detroit (TO. 8-3130), Chicago (PA. 5-1170), St. Louis (SW. 3584), Los Angeles (RY. 1-8343), Seattle (PR. 7513), Dallas (ST. 3335), Ft. Myers, Fla. (FO. 1269-M). In Canada: Cossor, Ltd. Toronto (PR. 1226) and Halifax (4-6488).
Export Agents: Frothom Co., New York City 18, (BR. 9-1296).

"HELIPOT" —T. M. REG.

IT PUTS THE SQUEEZE ON MAINTENANCE COSTS!

WESTON MODEL 633
CLAMP VOLT-AMMETER



A-C Current—five full scale ranges of 1000/250/100/25/10 amperes, with range overlap for good readability. Measurements under 10 amperes readily obtained.

A-C Voltage—three self-contained ranges of 700/350/175 volts insure accurate readability, in the upper half of the scale. Instrument insulated for 750 volt service.

Isolated Voltage and Current—with circuits insulated from each other, instrument can be connected to both voltage and current sources at same time.

Convenient 6 position switch—easily operated with gloved hand, a flick of the thumb selects any of the 5 current ranges, or the Volts position.

Adjustable pointer stop—red stop facilitates measuring starting current of motors.

Here's the instrument that produces big savings by slicing hours off maintenance schedules . . . produces worth-while revenue by forestalling costly repairs and shutdowns. Being so quick and simple to use, scheduled maintenance measurements are made more accurately . . . and trouble-shooting is simple and sure. Built to WESTON standards of safety, accuracy and dependability. Also available for A-C Ampere measurement only. Order through your local representative, or write . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey . . . *manufacturers of Weston and Tagliabue instruments.*

WESTON TAG

WESTON *Instruments*

9238

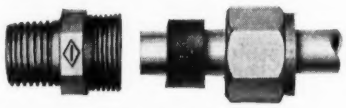
. . . TO INDICATE—RECORD—CONTROL

Whatever your Tubing Connection Problems....

Your Imperial Distributor has the Answer!

FASTER ASSEMBLY
VIBRATION
TUBE MOVEMENT
HIGH PRESSURE
SHUT-OFF VALVES
ALUMINUM INSTALLATIONS
TUBING TOOLS

IMPERIAL HI-DUTY FITTINGS — Unsurpassed for speedy, low-cost assembly. Withstands vibration. No loose sleeves to contend with. No flaring.



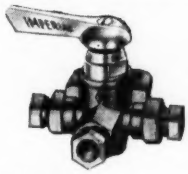
IMPERIAL FLEX FITTINGS — The tube coupling with the vibration and shock absorbing sleeve.

IMPERIAL FLARE FITTINGS — Both standard and heavy-duty types. Withstands severe tensile pull and high pressures.

IMPERIAL COMPRESSION FITTINGS —Simple, efficient, economical.

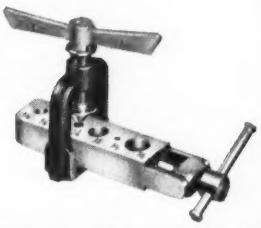
IMPERIAL FLEXIBLE HOSE and FITTINGS —For use where there is tube movement in lines for oil, grease, air, liquids, etc.

IMPERIAL ALUMINUM HI-DUTY FITTINGS — Ideal for all-aluminum installations. Lightweight, strong, good corrosion resistance.



IMPERIAL SHUT-OFF VALVES-2, 3 and 4-way. HI-DUTY and standard types.

IMPERIAL TUBING TOOLS
A complete line of the leading tools for cutting, flaring, bending, reaming and swedging tubing.



See Your Industrial Distributor • Ask for Catalog No. 350

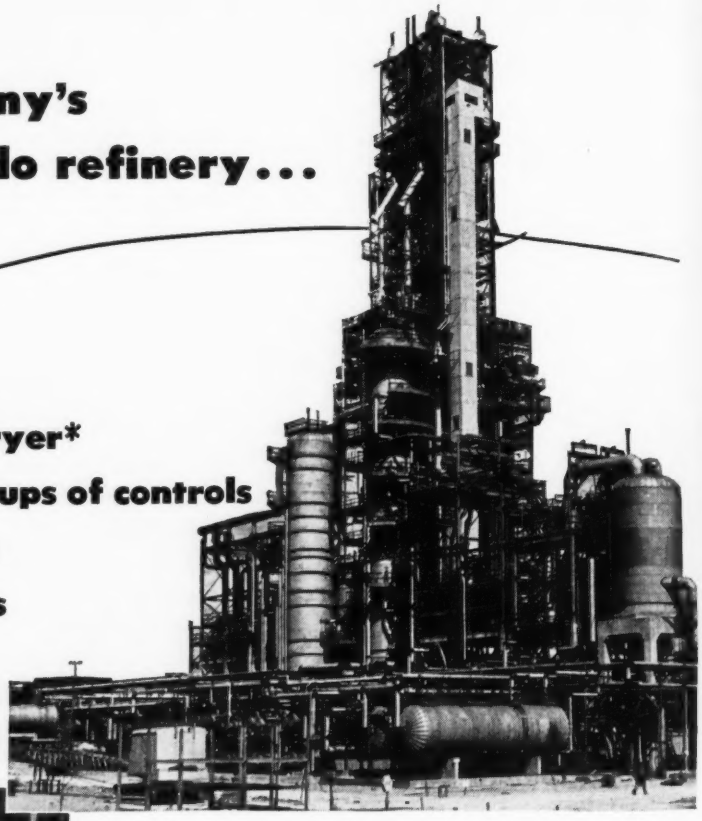
IMPERIAL

Pioneers in Tube Fittings and Tube Working Tools

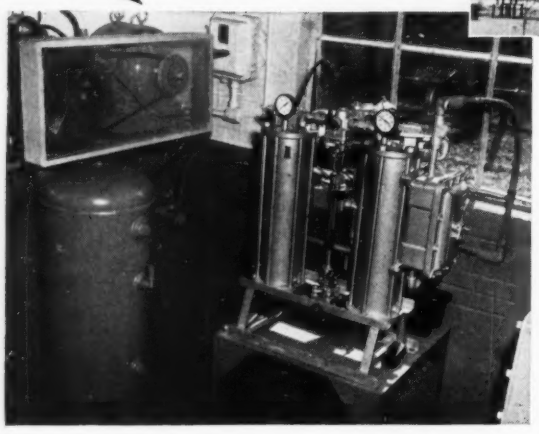
THE IMPERIAL BRASS MFG. CO. 120 W. Harrison St., Chicago 7, Ill. *In Canada: 33 Church St., Toronto, Ontario*

At Sun Oil Company's giant Toledo refinery...

this tiny Lectrodryer* prevents freeze-ups of controls for Susquehanna Pipe Line's pumps



Susquehanna Pipe Line Company's pumping station is located alongside Sun Oil's new Houdriflow unit, capable of producing 600,000 gallons of New Blue Sunoco gasoline daily.



This BAC-O Lectrodryer delivers DRY air to the tank serving instrument air lines.

"We had freeze-ups of air lines running to outdoor valves, low-pressure trips and recorders before we installed a Lectrodryer," said the man in charge of this pumping station. "Supplying DRY air to the lines stopped the trouble."

Similar reports come from many phases of the petroleum industry. Air in small volumes, as here, for controlling entire refinery operations; casing head and pipeline gases in huge quantities to prevent valve freeze-ups and corrosion; materials employed in processes to keep involved reactions on the beam—all are DRYing jobs handled by Lectrodryer, dependably and economically.

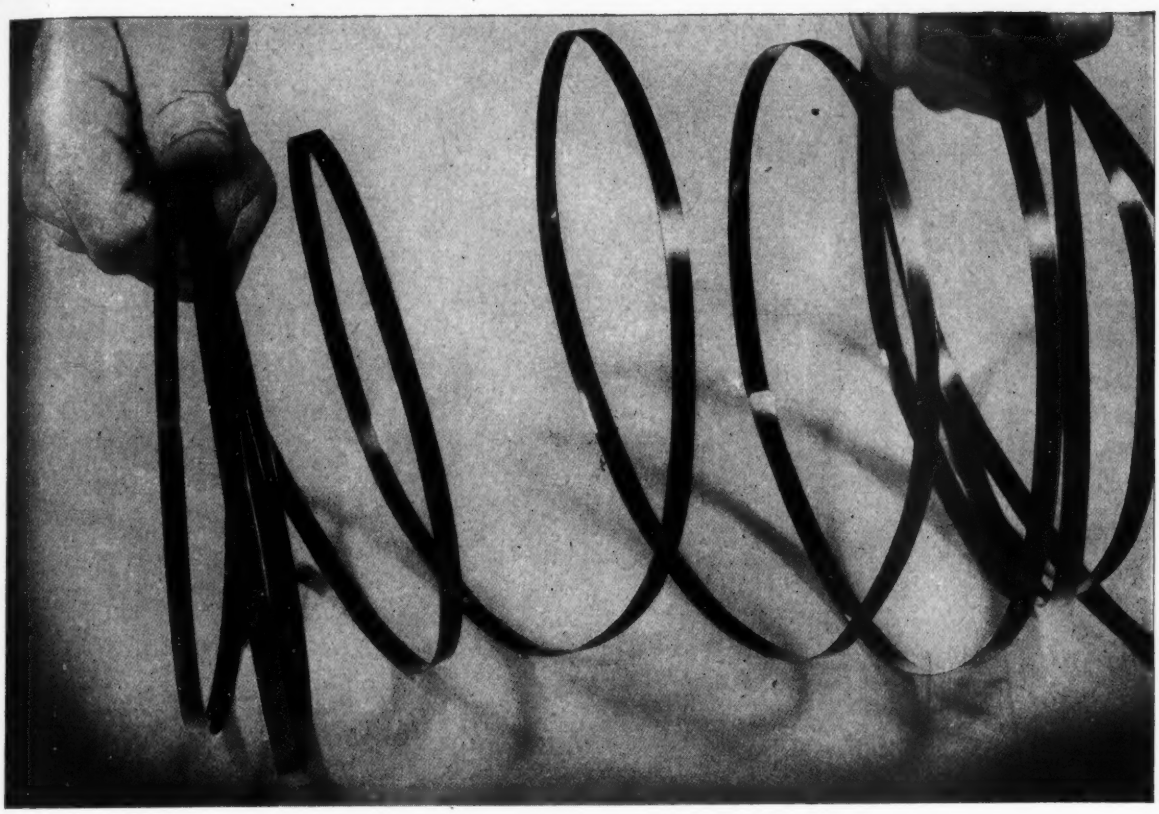
Standard Lectrodryers meet most DRYing requirements; no need for you to design and build special driers. And Lectrodryer engineers will save you more valuable time by helping you apply this equipment. Write Pittsburgh Lectrodryer Corporation, 330 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

Send for Bulletin 222 "Because Moisture Isn't Pink"

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

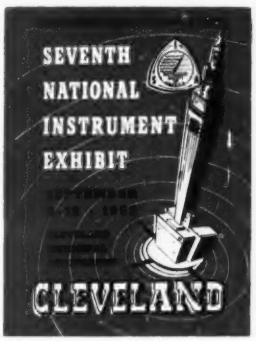


SPLITTING HAIRS IN STEEL
with Askania Hydraulic Control

A Pittsburgh district steel mill slits this ¼" rough edge from 15-ton reels of blackplate at 3,000 feet per minute with accuracy of ±1/64". They do this precision edge positioning job with Askania Hydraulic Edge Position Control.

This is only one example of Askania's method of converting low-level signals into large operating forces. This same Askania principle is used in hundreds of applications throughout industry.

Askania Regulators are widely used for combustion control in metallurgical furnaces and boilers; for blower controls; and pressure, flow, and proportioning controls in a wide variety of other applications. Wherever you need muscle in automatic control—for example, a lot of power from a pneumatic control signal—look into Askania.



See Askania Hydraulic Controls in operation at the Instrument Show — BOOTHS 415-417, or write for information.

ASKANIA HY-PERFORMANCE Hydraulic Controls

ASKANIA REGULATOR COMPANY

240 E. ONTARIO STREET • CHICAGO 11, ILLINOIS

A Subsidiary of General Precision Equipment Corporation

Added Evidence that——

Everyone Can Count on VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter, specially designed for flush mounting on panels and in instrument-clusters, can be connected in series to any device that has a contact arrangement. And it can be located at central *Count*rol-points, at a distance from the machine or process on which performance-figures are needed. Write for full facts.

VEEDER-ROOT INCORPORATED

"The Name That Counts"

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Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

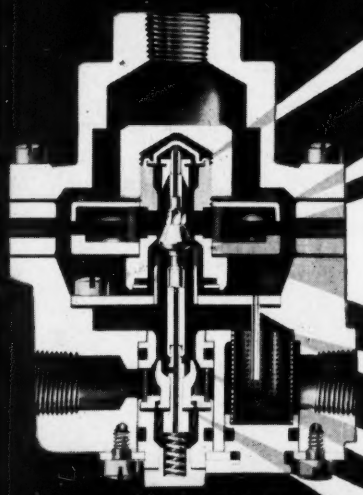
"Counts Everything on Earth"

Engineered Air Regulation

EVER SEE AN AIR VOLUME BOOSTER WITH AS HIGH RELIEF FLOW AS FORWARD FLOW?

THE KENDALL MODEL 20 PRECISION AIR VOLUME BOOSTER

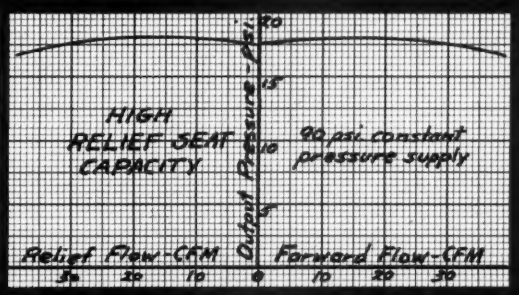
is a rugged, high capacity air volume amplifier engineered to speed up response in pnuematic lines, valve motors, and air cylinders. Available also in ratio form.



2/3 Actual Size

Deep convolution Nylon inserted Neoprene compensating diaphragm completely balances all undesirable relief seat forces.

Deep convolution Nylon inserted Neoprene main diaphragms with their unique rolling action assure constant area.



Flow compensating tube stabilizes booster action and compensates for downstream pressure losses by adding boost with increasing flow.

Statically and dynamically balanced supply valve of unusual capacity.

Deep convolution Nylon inserted Neoprene compensating diaphragm simply and effectively balances all undesirable supply seat forces.

PERFORMANCE

- Effect of Upstream Pressure Variations . . . 50 psi variation in upstream will result in less than 0.05 psi change in downstream pressure on dead end service.
- Pressure Differential on Flow Reversal . . . Change in loading or signal pressure required to change flow from forward to relief flow less than ±2" water.
- Sensitivity . . . The Kendall Precision Air Volume Booster responds to changes in signal pressure as low as ¼" water.

BULLETIN 4522 describes it

BULLETIN 4521 describes its companion precision air pressure regulator

KENDALL CONTROLS CORPORATION

144 MOODY STREET WALTHAM 54, MASS.

Combined for Service and Savings:

AUTOMATIC CONTROL

and INSTRUMENTATION

by HAGAN

Hagan Engineers have developed automatic control equipment and instruments which can be assembled into coordinated systems designed to meet your particular requirements. For example:

HAGAN AIR-OPERATED AUTOMATIC CONTROL EQUIPMENT includes pressure measuring and control units which may be combined into automatic control systems for process industries, metallurgical furnaces and steam power plants.

HAGAN THRUSTORQ is designed to measure forces and transmit a proportional signal to actuate a recording or indicating instrument, or an automatic control system. Typical applications include: automatic batch weighing, rocket thrust measurement, dynamometer testing of electric motors and internal combustion engines.

HAGAN RING BALANCE FLOW METERS are the most versatile meters available. Hagan Meters indicate, record, and integrate one or two flow rates. Standard modifications provide for pressure and temperature compensation. Ring assemblies are available to measure pressure differentials from 20" to 140" WC at static pressures up to 15,000 psig, and from 40" to 420" WC at static pressures to 2000 psig.

WRITE, WIRE or PHONE today for information about how Hagan Engineers can help you solve your industrial control and instrumentation problems.

HAGAN CORPORATION

HAGAN BUILDING
PITTSBURGH 30, PENNSYLVANIA

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

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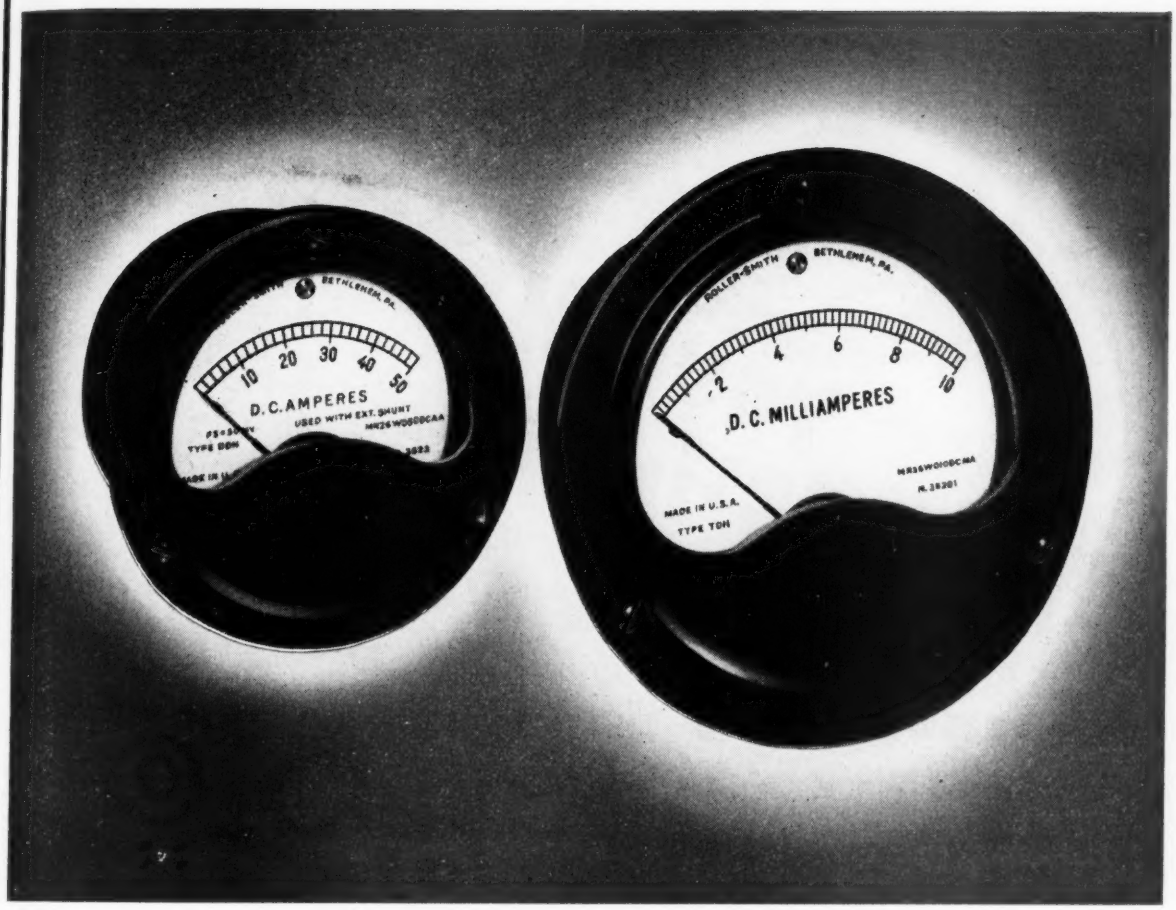


Roller-Smith
Ruggedized Instruments

Shock-Proof • Vibration-Proof • Weather-Proof

Roller-Smith announces production of hermetically sealed *Ruggedized* 2½" and 3½" instruments conforming to MIL-M-10304.

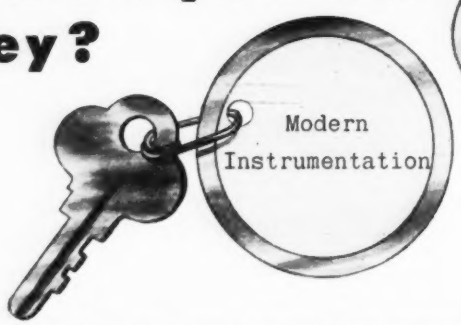
In addition to *Ruggedized* instruments, a complete line of hermetically sealed and unsealed types in conformance with Government specifications are available.

ROLLER SMITH

ROLLER-SMITH CORPORATION
BETHLEHEM, PENNSYLVANIA

are you SHACKLING PROFITS in your plant

...because you don't have this key?



Profits in your plant need not be shackled to today's high cost labor, materials, equipment. *Not if you utilize modern instrumentation to the maximum.*

Modern instrumentation eliminates costly by-hand processes—frees valuable manpower for other jobs—provides the precise control that makes possible modern manufacturing processes—conserves materials—improves product quality.

If you haven't recently looked into the possibilities of instrumentation in your plant—*do so at once!* You may be amazed at the savings you can make.

This message published in the interest of modern instrumentation by

INSTRUMENTS PUBLISHING COMPANY, Pittsburgh 12, Pa.

A sample copy of INSTRUMENTS—*The Magazine of Measurement and Control—will be sent on request.*

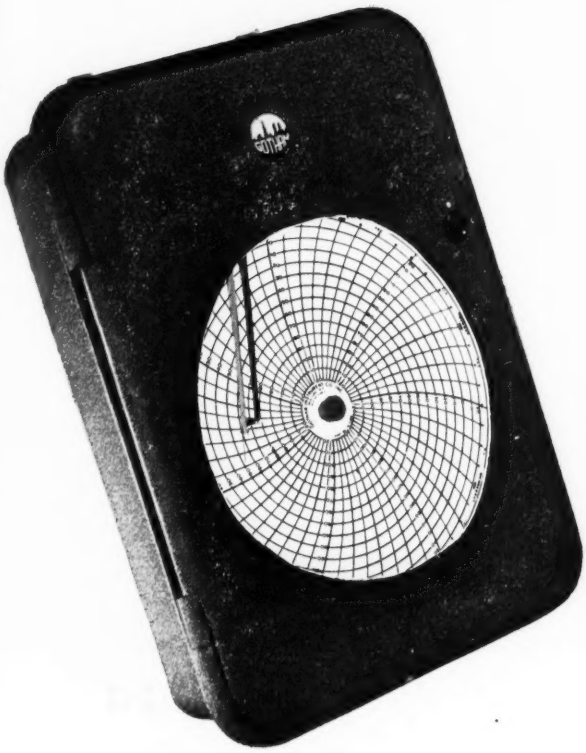
As just one example of the *tremendous savings* that can be achieved by *instrumentation*—a major chemical company recently reported in a field installation report—*savings of $1,500* monthly through the installation of just *one $360.80 instrument.*

Similar savings are experienced daily in all industries handling fluids, solids and gases.

THIS ADVERTISEMENT PREPARED BY WESTON-BARNETT, INC., WATERLOO, IOWA, ADVERTISING AGENCY FOR THE FISHER GOVERNOR CO., BURLINGTON INSTRUMENT CO., MARSHALLTOWN MANUFACTURING CO.

Reprinted from *Dun's Review*, April 1952

CHECK THESE 3 WAYS YOU CAN SAVE WITH THIS MULTI-PURPOSE INSTRUMENT



Here is the most sensible idea you've ever seen in a recorder or controller—an instrument you can change as your instrument needs change, that you can add to, subtract from, or whose functions you can increase or decrease at little or no expense.

✓ **Save money when you add new functions by adding only those new assemblies needed.**

✓ **Save time-delays by making changes on the job site without returning to factory.**

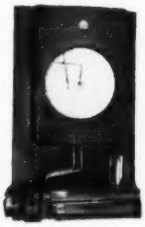
✓ **Save money on inventory. Parts are interchangeable, fit all Gotham Convertible recorders. You can service a whole group with a minimum stock of basic elements.**

What you can do with the Gotham Convertible

Depending on the chart size of the recorder (6″, 9″ or 12″) you can have a 1-2-3 or 4 pen recorder with 14 pressure, temperature and time operation combinations or a recorder-controller with 38 possible pressure, temperature, and time combinations.

SELF-CONTAINED PORTABLE RECORDER

A portable recorder which has a carrying handle, legs and retaining holder for capillary and bulb. Built from Gotham standard elements, interchangeable with other Gotham instruments. 6", 9" and 12" chart sizes. Mercury, Vapor or Pressure Activated. Spring or electric chart drive. See Catalog 400.



RECORDING PSYCHROMETER

Incorporates the same highly accurate and responsive thermal systems and contains all other Gotham standard convertible features. Wet and dry bulb type. Motor-driven suction fan. 12" chart size. Catalog 400.

RECORDING HYGROMETER

A 2-pen recorder of the wet and dry bulb type. Mercury or Vapor Actuated. 9" and 12" chart sizes. Available with variety of wet and dry bulb assemblies depending on application. Catalog 400.

GOTHAM INSTRUMENTS

Keep everything under control with Gotham

GOTHAM INSTRUMENTS
Division of American Machine and Metals, Inc.
Dept. 2, 233 Broadway
New York 12, New York

Please send me a copy of your

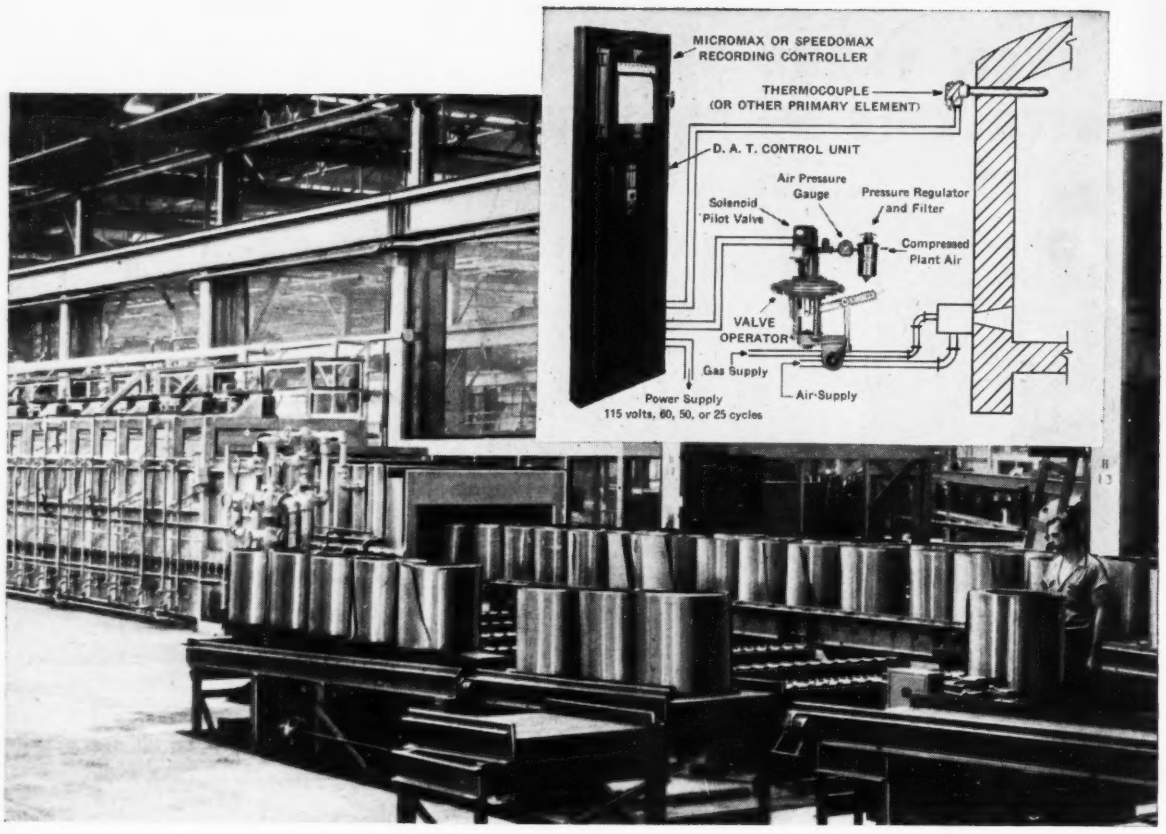
- ☐ Catalog 100—Industrial Thermometers
- ☐ Catalog 200—Dial Type Thermometers
- ☐ Catalog 400—Recorders, Psychrometers, Hygrometers
- ☐ Catalog 500—Controllers
- ☐ Have your representative call. No obligation.

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____



THIS "package" OF CONTROL FITS ITSELF TO FURNACE NEEDS

. . . and only L&N can supply all its features!

• Scovill Manufacturing Company credits pyrometric control of their 119-foot annealing furnaces with a big part in helping to produce the most uniform, high-quality brass they've ever made. Each furnace anneals sheet in 2000 lb. coils and has a capacity of 32,500 lbs. per hour. The four furnaces were built by Surface Combustion Co. and The Electric Furnace Co. for Scovill's 10 million dollar continuous strip mill.

Scovill's success in controlling temperatures is timely because it shows what can be done with thousands of other industrial furnaces. Small units may need only one instrument, instead of Scovill's five per furnace.

But the principle is the same.

Instead of arbitrarily turning fuel "on" at a predetermined low temperature, and "off" at a predetermined high, D.A.T. alternately turns heat on and off—flexibly adapting the periods of on-time to the needs of the furnace. When temperature begins to rise above the set-point, the periods of on-time become shorter. When temperature falls, periods of on-time grow longer. In this way, D.A.T. exactly adapts its action to the upsets, load changes and lags of the furnace. This means it holds temperature in line for all normal changes in furnace charge, ambient temperature, temperature control point, etc.

Increased production resulting from unusual uniformity is the great advantage of D.A.T. but other points are worth remembering:

Fuel can often be saved because less heat is lost up the stack.

Valve and burner sizes are not particularly critical.

D.A.T. can often modernize an old furnace, because it's so easy to install.

D.A.T. operates equally well on furnaces of full-muffle, semi-muffle, open firing and conventional radiant-tube design.

D.A.T. is just one of several L&N Controls. Call us for service or information in selecting equipment for any temperature-control problem. Address nearest office or 4955 Stenton Ave., Philadelphia 44, Penna.

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Editorial Comment

Computers and Industry

A LARGE FIELD of instrumentation operates at microsecond speeds. This is the new field of computing. The modern electronic computer is often called a "mechanical brain." This term leaves most industrial-instrument men cold—they have been using "mechanical brains" for 40 years in mechanical, electrical, hydraulic, and pneumatic controllers. For these men, the term "automatic data analyzer and processor" is more descriptive.

Electronic computing devices, which are now reaching full maturity in terms of the service they are prepared to render, have proved themselves remarkable timesavers in research, development, and classifying functions. Although military expenditures have nurtured their growth, their full maturity will have arrived when industry relies on them for many functions now done manually. The day is not far off.

Types of Computers

There are two basic types of computers—analog and digital. The former sets up the electrical analogy of any mechanical, pneumatic, thermal, hydraulic, chemical, or electrical system. By using the electrical analogy, by varying the basic parameters, and by examining the voltages and currents in the analogous electrical system, a complete system can be analyzed quickly for speed and type of response. Here is a basic research and development tool that is becoming a timesaver of millions of man-hours in all types of research and development. A new chemical process can be analyzed without building a pilot plant; a new aircraft design can be tested without building a pilot model. The analog computer will find even more uses in all phases of industrial research and development. (The reader is referred to seven new analog computers and components on pages 1023 and 1024.)

The *digital computer* accepts data in digital form (numbers) and multiplies, divides, integrates, tabulates, computes, selects, or performs many such steps in an "instruction program," which can be fed into the instrument. Large-scale statistical tabulations that might occupy a staff of people for a month can be performed by one digital computer in a few hours. Here is an instrument that all industries with data-handling problems must investigate. Here is an instrument that can provide the engineering and accounting departments of industry with operational and efficiency data within seconds of an inquiry. Here is an instrument with which the instrument man can become the central source of all operating and efficiency data, in addition to his normal duties. It must be noted that all the above are *in addition* to existing functions. The computers will not displace existing controllers—they will simply analyze, tabulate, and process the output of existing instruments. They will broaden the instrument field and make the instrument man even more a "key man."

As with all new instruments, their expanded use in industry will not displace men. Rather will they free the energies of men for more interesting and more productive work. For example, engineers now planimetering charts will have time to improve production techniques. Result: higher efficiency and happier engineers.

Not all the problems associated with computers are solved. One problem is the rapid insertion and extraction of information. Here is where cooperation between computer manufacturers and industrial-instrument manufacturers is essential. The computer will receive the output of existing pressure, flow, temperature, and analysis instruments. Thus the cooperation of manufacturers of the latter instruments is essential if the computer is to be used successfully. The output of the computer can be the data desired by the accounting department, or the engineering department, or the executive department of an industry. This will be no problem to the Instrument Department of the plant, whose personnel have long learned how to serve the needs of every department in the plant. Here is where the computer industry will find the "key" to the plant—the Instrument Department. The Instrument Department will enable the computer manufacturer to fit his product into its appropriate place within the organization. The Instrument Department will service the instrument and make it fit the needs of the plant.

It is true that industry as well as industrial-instrument men do not consider computers as a magical or awesome development with unlimited possibilities. This is as it should be. For 40 years industry has been using "mechanial brains" in mechanical, hydraulic, and pneumatic, as well as electronic controllers to control processes automatically. And industry demands a higher order of reliability than is customary in research and military work. This is because laboratories and military organizations are accustomed to larger maintenance staffs than is industry.

However, the computer industry will "come of age" only when (and not until) industry accepts computers as a basic instrumentation technique, using them wherever possible to analyze and process data. *Until* this occurs, the computer industry will have to depend on always uncertain military expenditures. *When* this occurs, the computer industry will have a stable, expanding market. Thus the wise computer manufacturer will do well to learn from his fellow manufacturers of industrial instruments how to sell to industry.

Best proof of the foregoing assertion is that the recent great increase in sales of computers to industry is caused in large part by the fact that many modern Instrument Departments now include men who thoroughly understand the value of computers—men who were trained in computer techniques during World War II in the Armed Forces, at M.I.T., at Bell Labs, etc. It is these well-informed "1952-model" Instrument Men who initiate the purchases of computers.

And the same is true of industrial purchases of computer *components*. Indeed, it is not uncommon nowadays (though it would have been rare a few years ago) for an Instrument Man to *specify* the computer components for an entire system.

—MFB & MHA

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(or, perhaps, of all twelve issues of Vol. 1—Jan.-Dec. 1928?)

Yes, we know that there are unmutilated copies of Vol. 1—and all subsequent volumes—in libraries; but we are after *individual owners.*

Please write to Historical Section, The Instruments Publishing Company, 921 Ridge Avenue, Pittsburgh 12, Penna.

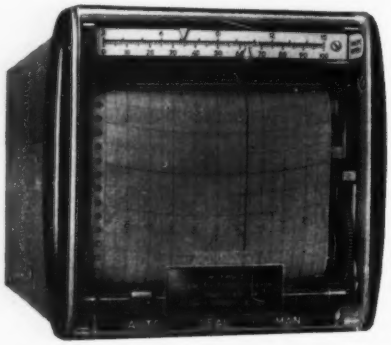
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1167

Panel Instruments

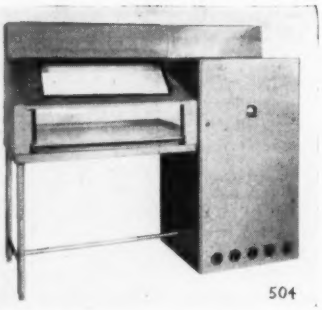
New "Consotrol" line of compact indicators, recorders and controllers, for graphic panels and instrument consoles, comprises four instruments: (1) "Model 52 Consotrol Controller" features a 4-in. indicating scale and a continuous valve position indicator; occupies 3.5 by 6.5 in. panel space, yet has all operating characteristics of full-sized motion-balance units. Control point setting, auto-manual transfer switch, and a manual control knob are case-mounted for easy adjustment. (2) "Model 53 Consotrol Recorder" (illustrated) uses a full 4-inch strip chart to provide a 30-day process record on a single roll. Five hours of chart visible without opening case. A separate scale indicates valve position and control set point. Overall panel size 6 by 6 in. (3) "Model 58 Consotrol Controller" is said to be "a new development in precision control," using a "floating disk" force-balance system which permits adjusting proportional band from zero to infinity. Reset time is adjustable over a 1000:1 range. (4) "Model 59 Consotrol Controller" is mounted directly on valve motor to control liquid flow, where orifice and control valve are in same line, thereby minimizing lag between controller and valve.—*The Foxboro Company, 26 Neponset Avenue, Foxboro, Mass.*



Mention No. 901 when filling out card.

Dust- and Germ-free Benches

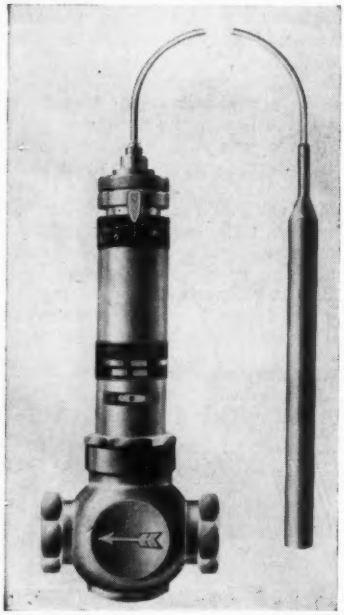
New models of "Sterilshield Cabinets," dust- and germ-free workbenches, have a central air-cleaning unit using electrostatic dust-collecting equipment and a blower to pressurize up to four workspace sections on either right or left. Other features: stainless non-magnetic steel pan for enclosed bench top; dual 30-watt fluorescent lamps; plate glass window in hinged sloping front which may be raised to admit large work; open front makes it possible to work without gloves, armholes or other limited access ports; a section pulls out and hinges upwards to close front opening when not in use; automatic switches start cleaning unit and blower; ultraviolet lamps added when desired to kill airborne bacteria.—*The Baker Company, Maplewood, Maine.*



Mention No. 902 when filling out card.

Temperature Controllers

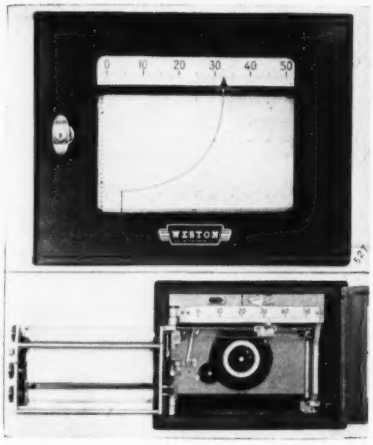
New "Series V" self-operated temperature regulators are available in sizes from 0.25-in. to 4-in., in either direct or reverse acting types for heating and cooling applications. Among features: (1) Field-replaceable thermostatic system. (2) Tight shut-off. (3) Positive, uniform throttling action. (4) Overload protection. Range limits 25 F. and 275 F., with a 50 F. range of adjustment.—*Farris Stacon Corp., 610 Commercial Ave., Palisades Park, N. J.*



Mention No. 903 when filling out card.

Self-balancing Recorder

New "Weston Recording Potentiometer" is a 10-inch strip-chart recorder of null-balancing (potentiometer) type, claimed to provide many exclusive operating advantages. Among new features: (1) Simplified chart frame swings out full 180 degrees, chart always remains in time sequence and pen lifts automatically. Charts changed in a matter of seconds. (2) Chart speeds, from inches per hour to feet per minute, quickly changed by a screw-driver adjustment; no special tools. (3) To change ranges, one only substitutes desired range standard on range panel: no soldered connections and no change in slide wire. (4) To change thermocouple reference-junction compensation, or to change reference point (0.0 mv.) on a millivolt range, compensation standard is quickly replaced in like manner. (5) A slider on range panel permits quick correction for instrument's electrical zero. (6) New pen never pumps or syphons-off, requires no priming after initial starting, won't tear records even at slow speeds, is driven by a woven stainless steel cable, is filled while instrument remains in operation and chart remains in time sequence. (7) Amplifier uses two 12AV7 and two 12AX7 tubes that require no matching and are available at radio supply stores, is removed by pulling two plugs and removing two holding screws. (8) Slide wire is universal and interchangeable, is 17.5 in. long, has 1700 turns. Flexible leads are eliminated by using a double-contact assembly. (9) Case is 15.75 x 11.5 x 14.75 in.; is readily adaptable to standard radio racks, has adjustable mounting brackets which permit mounting in all panels up to 1 in. thick without drilling bolt holes or using shims. Universal mounting: flush, wall and table. All servicing and inspection from front of



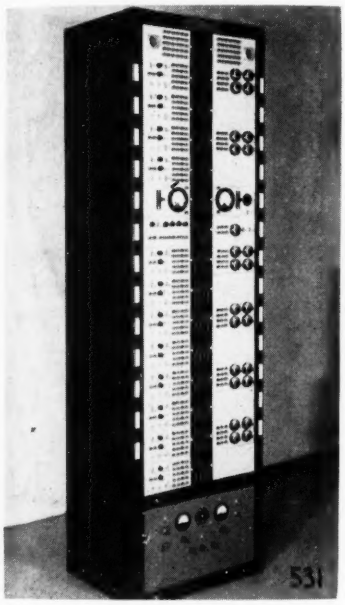
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

instrument. (10) Operational features: speed is approx. 1.5 seconds to cross chart on 60-cycle operation; accuracy within plus or minus 0.25 percent; higher accuracies available.—*Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.*

Mention No. 904 when filling out card.

Analog Computer

New Boeing Electronic Analog Computer, originally developed in 1947-48 for maker's own guided-missile work and now made available because of requests from other research groups, is

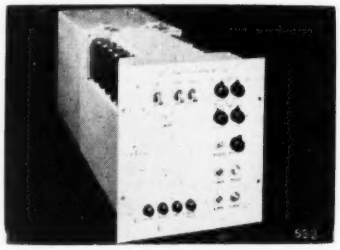


a low-cost system in its commercial form. Basic assembly comprises cabinet containing operational amplifier units, coefficient potentiometer panels, diode isolated limiters, voltmeter, volt box, power supply, control panel, patch panel and (not illustrated) patch-cord and hardware kit.—*Boeing Airplane Co., Seattle 14, Wash.*

Mention No. 905 when filling out card.

Function-generating Unit

New analog-computer component generates arbitrary functions for use in studies involving non-linear systems. Operating principle: cathode-ray tube



masked by Polaroid cards cut to desired function of input variable. Unit occupies two spaces in standard Boeing rack.—*Boeing Airplane Co., Seattle 14, Wash.*

Mention No. 906 when filling out card.

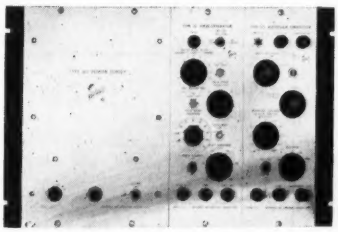
Analog Computer

New "Lineac" is a passive, reversible, non-iterative electrical analog computer for solving linear simultaneous algebraic equations, both scalar and complex. It uses no amplifiers. Solution is obtained immediately without any iterative process, either manual or automatic. Analog may be used in reverse for simulation of linear functions which are the sum of a number of terms each of which is the product of a variable and a constant. It consists essentially of multi-coil tapped transformers and a voltage divider; operates on 60-cycle voltage; requires little or no maintenance. For well-conditioned matrices of the order of ten or so, error is a fraction of one percent, and this accuracy can be extended to considerably higher orders by use of simple compensating adjustments. Non-iterative feature permits one-shot operation, and eliminates failure due to non-convergence of solution.—*American Hydromath Corp., 145 West 57th St., New York City.*

Mention No. 907 when filling out card.

Special-waveform Generators

New "Type 160" regulated power supply, (left-hand panel in illustration) "Type 161" pulse generator (middle) and "Type 162" waveform generator (right-hand) have been developed to fill a need in biophysics, geophysics, computer development, etc., for a source of precision waveforms with controllable characteristics. "Type 160" is capable of supplying a.c. and regulated d.c. voltages to operate six of "161" and "162" in any combination. "Type 161" pulse generator supplies rectangular pulses of known and variable amplitude and duration, positive or negative polarity; also a positive gate of same

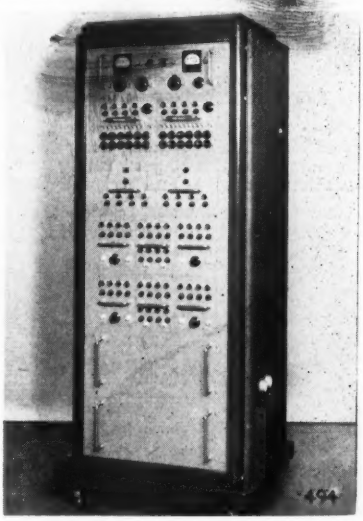


duration as pulse, and a delay facility. "Type 162" waveform generator provides a linear sawtooth waveform, a positive gate, and a positive trigger. Its operation can be gated, triggered or recurrent and can also be controlled by a push button, remote or on panel. In recurrent operation, repetition rate of these waveforms is variable. Instruments are combined easily to provide pulse conditions of almost any desired degree of complexity. By proper manipulation, "bursts" or groups of rectangular pulses provide tetanus stimulation. Pulse groups are variable as to number of pulses in group and group repetition rate, as well as to amplitude, duration and repetition rate of individual pulses. As number of units is increased, rectangular pulse combinations with more complex characteristics can be obtained to meet other requirements. Dimensions are such that a power supply and six units fit conveniently into two standard relay racks.—*Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.*

Mention No. 908 when filling out card.

Analog Computer

New "Model N2 GEDA" (nonlinear Goodyear electronic differential analyzer), for studies of high-speed mechanical systems with frequencies to 200 cps., operates on a one-to-one time scale and has an extended band width to facilitate solution of problems involving widely-separated modes of oscillation and a number of harmonics. It consists of plug-in multipliers, function generators, associated power supplies, and a calibrator. Time-division multipliers obtain products by generating a repetitive voltage wave form—amplitude proportional to one variable; duration ratio (within cycle) to a second variable. Amplitude- and ratio-modu-

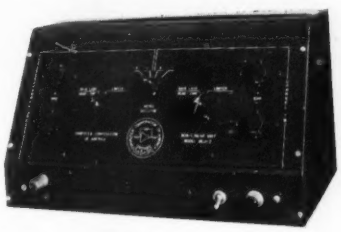


lated wave-form goes through a low-pass filter which rejects carrier frequency. Output is proportional to product of variables and obeys algebraic rule of signs. Function generators produce a series of connected straight lines for approximation of arbitrary curves. Two types: "A" accepting one input variable, producing two arbitrary functions of that variable, and changing shapes of functions; "B" accepting two input variables and producing an arbitrary function of each of those variables.—*Goodyear Aircraft Corp., Akron 15, Ohio.*

Mention No. 909 when filling out card.

Computer Component

New "Model NLU-2" unit provides simulation of backlash, dead-zone and limit-stops for any real-time analog



computer such as maker's "Ida" (see *Instruments*, July 1951, page 673). It has two independent channels, each of which may be set for any of the three

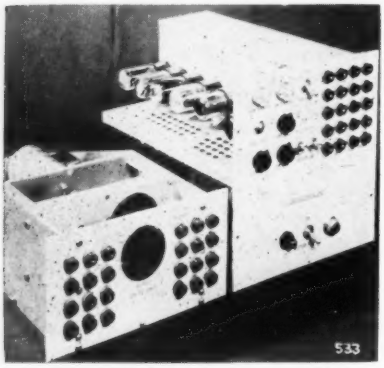
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

modes of operation. Variables of any magnitude normally encountered in commercial computers may be used as inputs. Complete and continuous front-panel adjustment of function to be generated is quickly accomplished. "NLU-2" may be used at higher frequencies than a servo-operated function generator. Accuracies of both types are comparable, but cost of obtaining backlash or dead-zone simulation on "NLU-2" is said to be a small fraction of cost of a single servo unit. New unit has a self-contained power supply operating from a 115-volt 60-cycle line and drawing 0.5 amp.—*Computer Corporation of America, 149 Church St., New York 7, N. Y.*

Mention No. 910 when filling out card.

Servo Unit for Computer

New Operational Servo extends utility of basic Boeing Analog Computer by providing a means of performing multiplication, division and trigonometric-

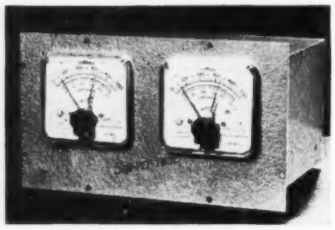


function generation. Consists of a d-c. motor tachometer, a high-gain amplifier and five single-turn ganged linear voltage dividers. Additional gears, sine-cosine units and other non-linear elements conveniently attached. Gear ratios variable. Unit can be operated as a position servo when necessary.—*Boeing Airplane Co., Seattle 14, Wash.*

Mention No. 911 when filling out card.

Duplex Temperature Controllers

New "Twin Simplytrols" control two heating elements, are functionally equal to two separate instruments: will control two separate furnaces or ovens.

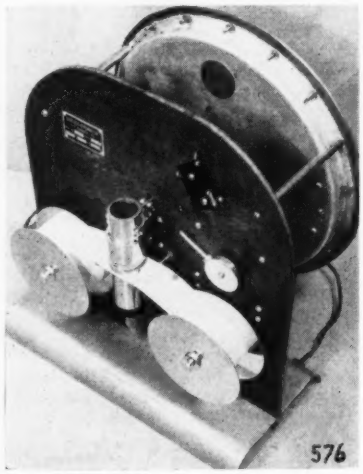


Units can have same range or different ranges. Any "Model 351-C" can be used in a Twin.—*Assembly Products, Inc., Chagrin Falls, Ohio.*

Mention No. 912 when filling out card.

Automatic Intermittent Smoke Sampler-recorder

New "A.I.S.I. Automatic Smoke Filter," for air-pollution surveys, aspirates air (at rate of 0.25 cfm.) through a

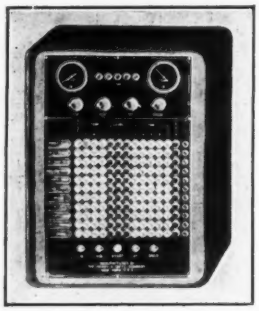


1-in. circle of pure filter-paper fed from a spool and shifted periodically (two to five times per hour). Each spot serves not only for blackness measurement but for analysis of sample by chemical and physical methods.—*Research Appliance Co., Box 419, West View Road, Pittsburgh 9, Penna.*

Mention No. 913 when filling out card.

Program Controller

New "Cat. 125 Timed Operations Preselector" provides for adjusting timing of each cycle of a process independently; can be used to energize

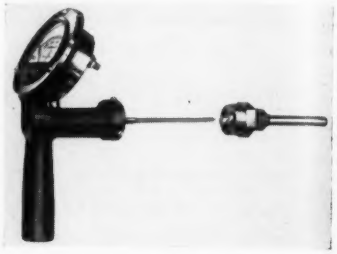


a number of electrical devices or circuits during a single cycle of a process. Unit illustrated (for laundry machinery) selects time, temperature, and water level of each of eleven wash cycles, has contacts available to provide pilot light indications of circuits, and means of starting and stopping washer motor. Unit consists of a single synchronous motor timer which delivers a repetitive fixed time impulse. Any multiple of this impulse can be preselected by means of pushbuttons for desired time interval of each cycle. Sequence of any one cycle can be changed without affecting change in other cycles.—*The Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.*

Mention No. 914 when filling out card.

Diesel-engine Pyrometer

New "Model 4-321" portable diesel engine pyrometer is designed for test purposes and for installations where no



permanently mounted pyrometer is available. Thermocouples can be installed in each cylinder and in main exhaust line. Temperatures can then be checked at any time by inserting pyrometer prongs into corresponding receptacles in terminal head of thermocouple.—*The Bristol Company, Waterbury 20, Conn.*

Mention No. 915 when filling out card.

Time Controller

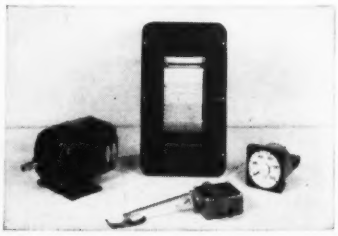
New "Promatic Electronic Timer," for controlling timed operations between 60 milliseconds and 60 seconds, utilizes discharge of a resistor-capaci-

tor network through a gas tetrode. Time period is set manually; commences upon closure of any external switch; control contacts either open or close at end of timing, depending upon circuit requirements. "Promatic" is similar in appearance to maker's synchronous-motor timer, permitting "matched timer housings" for use in dual-timer applications.—*General Control Co., Boston 34, Mass.*

Mention No. 916 when filling out card.

Tachometer Kits

New tachometer kits contain all components necessary to provide instantaneous and permanent records of machine performance at a central lo-



Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

IMMEDIATE DELIVERY

From Stock

fully armored all-metal FLOWRATOR meters

Delivery right from Fischer & Porter stock in Chicago, Dallas, Los Angeles and Hatboro means much to you.

Now you can have the wide range, linear scale Fig. 52 all-metal meter quickly in 150 lb. and 300 lb. ratings in steel or 316 stainless. These meters are complete meters and not just metering elements, are low in price and may be equipped with Magnabond pneumatic transmitters (illustrated) or all-metal magnetic indicators which are regularly stocked. Six sizes in FLOWRATOR Meters will cover a capacity range from a *fraction* of a GPM (or SCFM) to 240 GPM (or 850 SCFM). Each meter, with Stablvis float, has a viscosity immunity well above that found in orifice practice.

Further, Fig. 52 meters can be changed for different applications—right in the field—by use of the information contained in the F & P Variable Area Handbook.

If you would like further information on Fischer & Porter Flowrator Meters—or a free copy of the Variable Area Handbook—check and return the handy coupon now!

5 DISTINCT FEATURES:

- One moving part, no stuffing box
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FLOWRATOR

Fig. 52 Flowrator Meter equipped with Magnabond pneumatic transmitter.

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2½" MODEL R-210

3½" MODEL R-310

MEETS MIL-M-10304

- Mechanism suspended by internal live rubber ring mounts for maximum shock displacement and protection.
- External live rubber grommet for shock mounting with interlocking part of front bezel eliminates glass breakage and bezel distortion.
- Water-tight seal to panel provided by rubber grommet.
- Glass to metal seal for perfect hermetic sealing.
- Drawn steel case with heavy cadmium plate provides high degree of magnetic shielding.
- High-grade fusion seals for terminals and window glass withstand thermal shock of extreme temperature changes.
- Rugged glass-to-metal seal terminals withstand a 3000 volt breakdown test under extreme humidity conditions.
- Entire mechanism has complete ruggedized construction for high shock and vibration resistance.

Ranges from 250 microamperes to 8 milliamperes D.C. available for immediate delivery in 2½" size. Other ranges in 2½" and 3½" being submitted for government approval.

A request on company letterhead to Dept M-N will put you on our mailing list, and bring you BULLETIN 200N.

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45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.

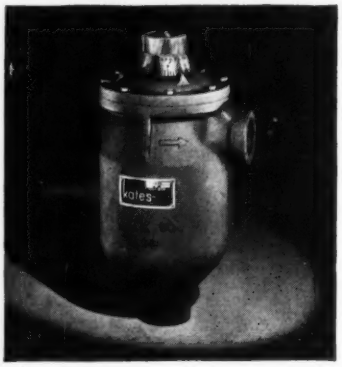
NEW INSTRUMENTS

cation. Four kits are available in new line. A typical installation would include a d-c. tachometer generator, a tachometer indicator, a switchboard-type tachometer recorder, and (where a continuous web of material is produced) a web-break detector. Audible or visual alarm systems are optional accessories.—*General Electic Co., Schenectady 5, N. Y.*

Mention No. 917 when filling out card.

Flow-rate Controller

New modifications in maker's direct-acting flow-rate regulator are said to provide greater accuracy and better performance on all liquid flow control



problems, than provided by previous models. New models are available with standard capacities from 0.1 to 100 gpm of water, are accurate to within 3 percent. Larger capacities and greater accuracy can be furnished. Installation requires no special tools, and can be made quickly.—*W. A. Kates Co., Deerfield, Ill.*

Mention No. 918 when filling out card.

Hand Tachometer

New "Universal Hand Tachometer" is of centrifugal class, cross-pendulum type which permits use in any position. Rotating gear-shift selects any of three

ranges. Two range combinations: 25-30,000 and 30-40,000 rpm. Pointer makes almost two complete revolutions for each range. Cutmeter wheel is supplied. —*O. Zernickow Co., 15 Park Row, New York 7, N. Y.*

Mention No. 919 when filling out card.

Motor-frequency Control

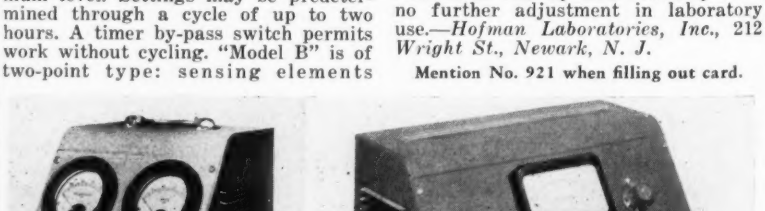
New "Change-A-Cycle" adjustable field resistor for dc.-to-ac. rotary converters enables output frequency to be set for each application; provides frequency control for mobile wire and tape recorders where battery voltage may fall below input nameplate rating and recording must be made at exactly 60 cps. Any drop in output frequency can be restored to 60 cycles by removing dc. input end cover of converter and adjusting "Change-A-Cycle." Frequency can be measured with a vibrating-reed frequency meter. "Change-A-Cycle" does not regulate ac. output voltage.—*Carter Motor Co., 2644 Maplewood Ave., Chicago, Ill.*

Mention No. 920 when filling out card.

Low-temperature-liquid Level Controllers

New automatic level controllers are designed especially for laboratory work with low-temperature liquids. "Model A" has time-rate feature with one sensing element: a solenoid valve is controlled for maximum level by a gage and an automatic timer controls minimum level. Settings may be predetermined through a cycle of up to two hours. A timer by-pass switch permits work without cycling. "Model B" is of two-point type: sensing elements mounted top and bottom; solenoid valve, and discharge device. In both models, solenoid valve can be operated manually. Pilots and indicators show when gage is being supplied with current and when solenoid valve is open. Gage current is adjustable. Both models are calibrated at factory and normally need no further adjustment in laboratory use.—*Hofman Laboratories, Inc., 212 Wright St., Newark, N. J.*

Mention No. 921 when filling out card.

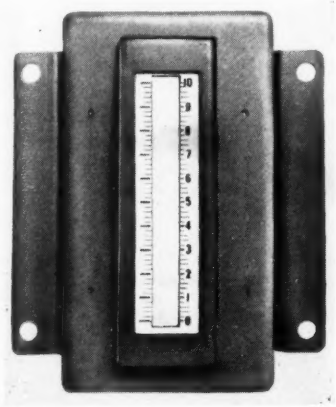


538

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Miniature Indicators

New miniature indicators for liquid level and valve position occupy minimal panelboard space; give illusion of a liquid-level sight-glass by using a

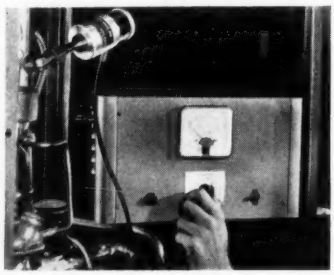


colored metal tape which moves vertically behind indicating scale. Reverse or direct action is obtained by means of a linkage attached to a standard 3-15-psi. pneumatic receiver, which provides sufficient force to eliminate tapping error.—*Industrial Div. Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 922 when filling out card.

Vacuum Gage

New "Type PHG-09 Philips Gauge" covers a range of 8,000,000:1 (0.5mm. to 10^{-7}mm. Hg.) from an all-metal pick-up tube in which permanent mag-



nets provide a field which lengthens electron paths into tight spirals that give high ionization per electron, with a cascade effect. Having no filament to burn out, new tube can be operated at full atmosphere without damage. With magnets external to ionization chamber, there is no problem in outgassing or removing stray iron particles.—*Vacuum Equipment Dep't, Distillation Products Industries, Ridge Road West, Rochester 3, N. Y.*

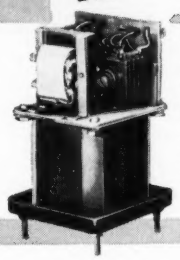
Mention No. 923 when filling out card.

Water Vapor Indicator

New model of "Aminco-Weaver Water Vapor Indicator" measures water-vapor content of compressed gases within range of saturation down to 0.003 mg./l. or less. Accuracy within 10 percent of amount of water present. Measurements reproducible to 0.002

Specified for Precision Performance!

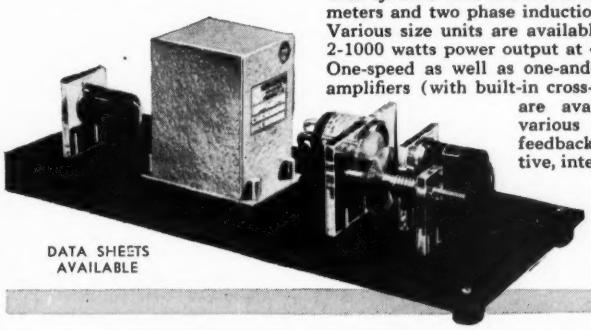
STANDARD PACKAGED PUSH-PULL MAGNETIC AMPLIFIERS by MA



MAGNETIC AMPLIFIERS—These high gain, high performance Magnetic Amplifiers are especially suitable to drive two phase induction servo motors requiring from 0.1 watt to 20 watts per phase on either 400 cps or 60 cps powerlines. The output power is either in phase or 180 out of phase with the powerline depending on the D.C. input signal polarity. Catalog Available.

SATURABLE TRANSFORMERS, REACTORS — Lower power gain, Magnetic Amplifiers designed to drive two phase induction motors. Output powers available are from 0.5 watt to 1000 watts, 400 or 60 cps. Catalog Available.

STANDARD TUBELESS SERVO AMPLIFIERS with built-in adjustable SERVO LOOP STABILIZATION. Packaged, completely self-contained, magnetic servo amplifiers for position servo systems where either A.C. or D.C. error signals are available. Designed for instrument type and power type servo systems to work with synchro control transformers or potentiometers and two phase induction servo motors. Various size units are available ranging from 2-1000 watts power output at 400 and 60 cps. One-speed as well as one-and-36-speed servo amplifiers (with built-in cross-over networks) are available utilizing various forms of loop feedback such as derivative, integral, and tachometer feedback. Special units designed to meet your needs.



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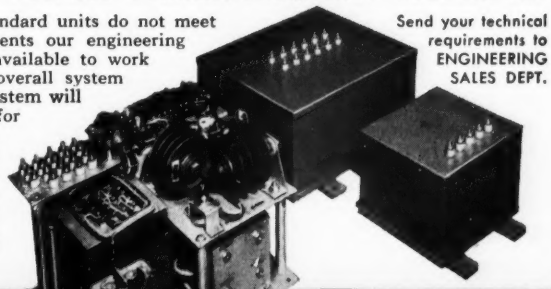
Send your technical requirements to ENGINEERING SALES DEPT.



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"stretch or shrinkage" of metal
MEASURED & RECORDED
down to .0001 inch!

Electro
ELECTRONIC EQUIPMENT

MEASURES WITHOUT CONTACT

EPL Dynamic Micrometer easily measures displacement, vibration or movement (up to .075 inches) of any metal body without contact. Sensing unit is calibrated for direct reading and measures object without physical "loading". Measurements are made at any speed and are independent of acceleration or frequency of displacement.

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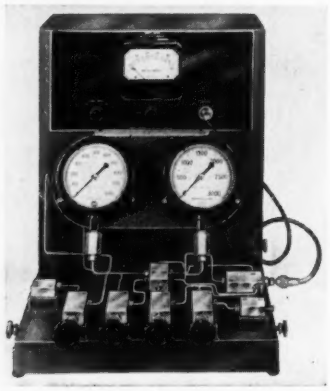
ALSO MEASURES
Radial expansion of objects at high speeds.
Motor vibration, valve travel, bounce.
Shaft whip.
Eccentricity of commutators, slip rings.
Vibration in heat exchangers.
Axial vibration in turbo compressors.
Displacement, rate of acceleration.
Travel, bounce of relay contacts.
Write for Bulletin DM1250

NEW INSTRUMENTS

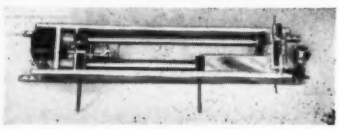


mg./l. Water-vapor content of gas being tested is determined through comparison with water-vapor content of a standard gas, saturated under pressure and expanded to atmospheric pressure. Determinations are made in 2 to 5 minutes as compared to several hours by gravimetric method.—*American Instrument Co., Inc., Silver Spring, Maryland.*

Mention No. 924 when filling out card.

Infrared Gas Analyzer

New "Model 15" infrared gas analyzer is of positive type, features flexibility enabling user to adapt it for any gas that can be analyzed by in-



frared means: changing detector cell takes approximately ten minutes. Length of absorption cell and filter cell when required can be varied from 0.05 in. to 12 in. to cover full-scale concentration ranges from 100 percent to 0.05 percent for most gases.—*Liston-Becker Instrument Co., Inc., 30 Beckley Ave., Stamford, Conn.*

Mention No. 925 when filling out card.

Rotary Accelerator

New rotary accelerator provides a controlled variable centrifugal acceleration from 0.1 to 100 *G* for calibrating or testing instruments, sub-assemblies, small mechanisms, etc. Rotating

table is a 16-in. Dural disk on which a test object weighing up to 5 lbs. may be mounted. For testing electrical devices, six silver sliprings are provided, each with two silver graphite brushes: power and signals transmitted with low noise levels at all rotational speeds. —*Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.*

Mention No. 926 when filling out card.

Dynamic Pressure Indicator

New seven-channel "Model ST-127 Electronic Pickup Indicator" measures transient, recurrent and static pressures using oscilloscope presentation. Custom-built units for rack mounting, offering up to seven channels on standard 19-in. panel complete with regu-

lated power supply. Operation based on phase modulation principle using carrier frequency of about 12.5 Mc. Capacity-type pickup having diaphragm with 0.187-in. free diameter enables uniform response to pressure transients having high-frequency components. Response from 0 to 100 kc. depending on diaphragm thickness. Pressure pickups available having replaceable diaphragms covering ranges from 1 to 30,000 psi.—*Rutishauser Corp., 490 So. Fair Oaks Ave., Pasadena 1, Calif.*

Mention No. 927 when filling out card.

Moisture Tester

New "Model G5" tests moisture content in virtually any non-metallic dry granular material. It consists of (1) master measuring unit; (2) range box;

(3) sampling unit consisting of electrode and sample cup; and (4) hydraulic press which obviates need of weighing samples. Measuring unit remains same for all applications; other three units can be interchanged for wide variety of materials or moisture ranges. Another exclusive feature is suppressed zero which spreads moisture range over entire microammeter dial. —*Moisture Register Co., 1510 W. Chestnut St., Alhambra, Calif.*

Mention No. 928 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Accelerometer

New "Type 1AB-C" accelerometer meets requirements for control systems in aircraft and guided missiles; conforms to AN-E-19. It contains a four-active-arm reluctance bridge (excited by a 400-cycle source) and a seismic

system consisting of a mass, spring, and armature assembly. Damping to individual user needs is accomplished by changing temperature of silicone fluid, by a thermostat and a heater energized from 28-volt d-c. supply. Unit is hermetically sealed, has a sealed Cannon connector. Weight 37 oz. Special feature is extremely low quadrature voltage content in output signal over wide temperature span outlined in AN-E-19. Standard full-scale range is 0.5G to 25G. Full-scale ranges below or above on special order.—*Wiancko Engineering Co., 255 N. Halstead St., Pasadena 8, Calif.*

Mention No. 929 when filling out card.

Magnetic Amplifier

New "F5A Magnetic Modulator" for general industrial use converts low-level d-c. signals into proportional a-c. signals; was originally developed for

automatic IIS approach coupler for use with maker's "F-5 Autopilot" for jet aircraft. In industrial applications, it is recommended for use as measurement or control system prime relay, responding to output of thermocouples, strain gages, etc. In this capacity, it not only replaces vacuum tubes but adds several advantages: low distortion, almost unlimited life, and extreme linearity with stability. "F5A" is shock-proof, hermetically-sealed and magnetically-

HIGH SPEED Potter INSTRUMENT COMPANY, INC. ELECTRONIC

COUNTING TIMING CONTROL

INSTRUMENTS

FOR APPLICATIONS INVOLVING THESE BASIC MEASUREMENTS

CALCULATION + — ÷ X

For business, industrial and scientific applications requiring computation, data handling, memory and high speed printing, the Potter Instrument Company can supply complete systems. Some of the newly developed equipments include simplified electronic arithmetic units, multipurpose shift registers, storage devices, photoelectric readers, tape handlers and high speed line-at-a-time printer.

QUANTITY

Pills, buttons, bottle caps, hardware, etc., can be counted and batched in precise predetermined quantities at speeds up to 60,000 per minute. Important savings in labor and overages are assured by the speed and accuracy of the Potter Electronic Counter. Count Detectors for any product are available.

LENGTH

Wire or strip material can be automatically sheared or marked in precise predetermined lengths at high rates of speed, and if required, automatically stacked in predetermined quantities. Practically any definition of measurement can be obtained.

TIME

Time intervals can be easily measured or generated with extremely high accuracy through the use of Potter Counter Chronograph Interval Timers. Registration of measurement is retained until reset. Accuracy of one part in 8,000,000 can be provided.

SEQUENCE

Since the electronic counters can be arranged to predetermine any sequence of selected counts, they can be readily and advantageously substituted for cams, gears, patterns, chains and other systems of timing control. Control by absolute count assures high accuracy, faster operating speeds, since there are no moving parts to wear.

FREQUENCY

Potter Electronic Counters provide an exact ratio of division which is maintained even though the input frequency is varied. If the input frequency is stopped the output also stops. Frequencies can be measured or generated with high precision. Square waves of variable frequency, pulse-width and number can be easily generated.

REVOLUTION

Through electromagnetic or photoelectric pickup, shaft rotation can be accurately counted or timed without physical contact. Fractional parts of a revolution can be measured or used to control automatic machine processes as a function of predetermined counts.

PROBLEMS ?

Your specific counting, timing or control problem, explained on our data sheet, will result in a prompt and efficient solution by our engineers.

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Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

VISIT BOOTH 513
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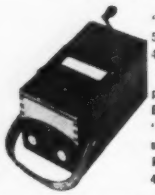
PRECISION INSTRUMENTS

MEGOHMER
INSULATION TESTERS
GENERATOR TYPES



"MINOR" Dwarf Size 3 lbs. 500 Volts, 50 megohms, Bull. 450
"MAJOR" Small size constant pressure, 500 Volts, 50 megohms Extra ohm scale, Bull. 465
"STANDARD" Heavy duty constant pressure 500 or 1000 Volt. Ranges to 2000 megohms, Bull. 455

BATTERY VIBRATOR TYPES

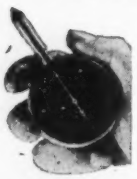
"MODEL B-7" Precision Ohmmeter-Megohmmeter. 2 megohm ranges, 2 ohm ranges, 2 test potentials. Bull. 440
"MODEL B-6" 4 instruments in 1. Ranges: 200 megohms, 2000 ohms, AC & DC volts up to 600. Bull. 441

ELECTRONIC TYPES

"MODEL 29A" Measure resistances from .3 to 20 million megohms. Test potentials 85V and 500V DC. Bull. 1029
"ENGLISH ELECTRIC TESTER" Adjustable test voltage from 500 to 10,000 volts DC. Range: 100-250,000 megohms, Bull. ES106

TACHOMETERS

HAND TYPES
TYPE "U"
UNIVERSAL
CENTRIFUGAL TYPE
5 Ranges in 1 Instrument
Cat. No. 303 30-12,000 RPM
Cat. No. 314 45-18,000 RPM
Cat. No. 322 60-24,000 RPM
Cat. No. 346 120-48,000 RPM
Bulletin 750



"JAQUET"
SPEED INDICATORS
(CHRONOMETRIC)
Guaranteed Accuracy within ½ of 1%
Cat. No. 2301 0-10,000 RPM
Cat. No. 2302 0- 1,000 RPM
Suitable double rated speed. 8 models, various accessories.
Bulletin 735

STATIONARY TYPE
MODEL "J"
Sizes 3", 4", 5½", 8", 10", and 20" dial diameter, flexible shaft driven.
Many standard ranges reading RPM, FPM, YPM, etc.
Bulletins 795, 796, 797

HERMAN H. STICHT CO., INC.
27 PARK PLACE NEW YORK, N.Y.

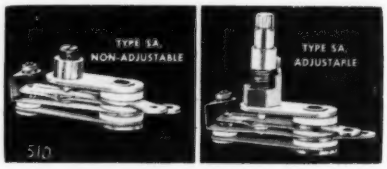
NEW INSTRUMENTS

shielded; operates over a wide frequency range; is virtually unaffected by temperature changes.—*Lear, Inc.*, 11916 *West Pico Blvd., Los Angeles* 64, *Calif.*

Mention No. 930 when filling out card.

Snap-action Thermostats

New line of bimetal strip thermostats for use in percolators, vaporizers, controls for furnace fans, sterilizers, etc., comprises "Type SA" available in either adjustable or non-adjustable

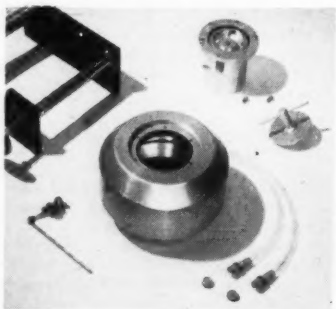


styles; also "Type SM" manual-reset (not illustrated). Units can operate on differentials as narrow as 10 F. or as wide as 100 F. Electrically independent bimetal element reduces artificial cycling and life-shortening "jitters."—*Stevens Mfg. Co., Inc.*, 69 *S. Walnut St., Mansfield, Ohio.*

Mention No. 931 when filling out card.

Ultracentrifuge Batch Rotor

New bowl-type rotor for use with Spinco Model L Preparative Ultracentrifuge permits batch samples as large as 1600 ml. to be ultracentrifuged up

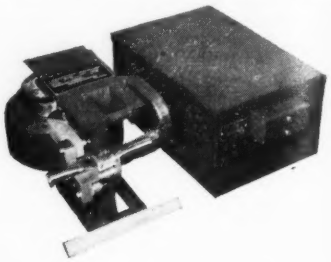


to 20,000 rpm. under controlled temperature conditions; is so designed that all parts can be sterilized; consists of (1) main bowl with two internal grooves; (2) removable central core; (3) lid-handle assembly. Core includes two filling holes with plugs for which can be substituted plastic discharge tubing. Packed sediment is extracted with a plastic scraper or resuspended by use of stainless steel balls and a motor-driven rolling fixture (illustrated upper left). A magnet is supplied for withdrawing balls without removing center core.—*Specialized Instruments Corp.*, 655 *O'Neill Avenue, Belmont, Calif.*

Mention No. 932 when filling out card.

Electromagnetic Pump for Molten Metals

New a-c. electromagnetic pump with no moving parts, for pumping liquid metals and other low resistance conducting fluids at temperatures up to 1000 F., can be used to move any conducting fluid that has a specific resistance equal to or less than stainless-steel (approx. 90 microhm-cm.): liquid metals such as sodium, sodium-potas-

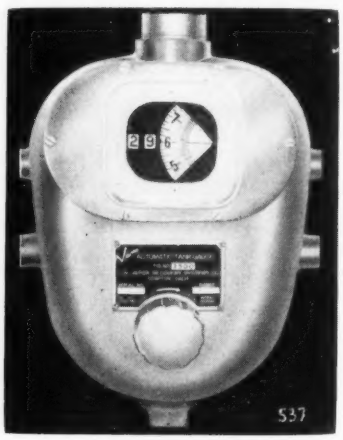


sium alloys, and lithium. Operating principle is converse of that of G-E flow-rate meter for liquid metals (*Instruments*, July 1952, page 864): a current-carrying conductor in a magnetic field is acted on by a force. In this case, fluid serves as conductor, so that when current and flux are properly applied, pumping occurs.—*General Electric Co., Schenectady* 5, *N. Y.*

Mention No. 933 when filling out card.

Liquid Level Indicator

New "Figure No. 2500, Automatic Liquid Level Gauge" for low-pressure storage tanks has a direct-reading counter in "Look Box" for quick accurate reading of foot increments, and a dial for reading inches and fractions



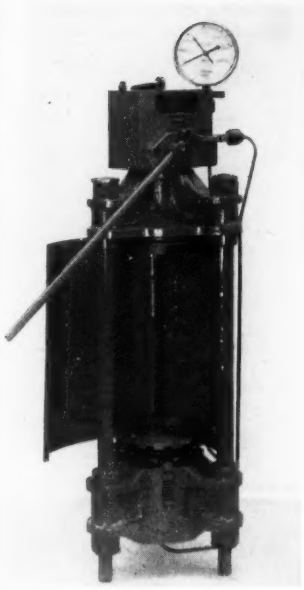
of tank contents. "Neg'ator Motor" maintains a predetermined constant tape tension, obviating need for conventional counterweight. Other features: (1) "Look Box" may be installed at any desired height from ground or on top of tank. (2) Gas-tight Look Box adaptable for installation on many existing float-operated automatic tank gages. (3) Gravity Compensator is incorporated. (4) Gage is designed to permit later installation of maker's electronic transmitters.—*Vapor Recovery Systems Co., Compton, Calif.*

Mention No. 934 when filling out card.

Concrete Compression Tester

New portable 300,000-lb. compression tester is for testing standard 6 x 12 in. and 8 x 16 in. concrete cylinder

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

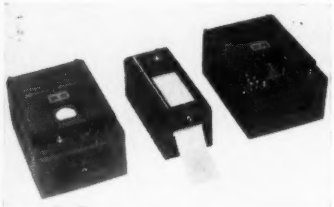


specimens on the job. Specimen is placed between two compression surfaces, upper one self-aligning; load is applied by a hand piston pump; gage is provided with a maximum-load pointer.—*Tinius Olsen Testing Machine Co., 1116 Easton Road, Willow Grove, Pa.*

Mention No. 935 when filling out card.

Welding Analyzer

New "Model BL-213" direct-writing Welding Analyzer records single-phase and three-phase resistance welding machine variables. Welding current and



electrode force records show squeeze, weld, hold, and off time intervals. New analyzer also records 180-cps. component present in 3-phase welding machine current when ignition rectifiers are used.—*Instrument Div. 33 E, The Brush Development Co., 3405 Perkins Avenue, Cleveland 14, Ohio.*

Mention No. 936 when filling out card.

Single-tube Hydraulic Position Transmitter

New "Hydrotorque" hydraulic remote-positioning system is a single-tube system independent of outside power-source. Eliminating "sponginess," it is said to give the operator the "feel" of direct linkage and the confidence of positioning within a thousandth of an inch. New system can be utilized in locations previously considered impracticable because of corrosion, high heat,

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

An achievement in *automatic data analysis* . . .

the Teleplotter

plots graphs 10 times faster than by hand

operates from IBM card or keyboard digital input

A new problem has developed in modern science and engineering—the problem of manual plotting.

The slowness, fatigue, human errors of manual plotting frequently cause serious time lags, increase expenses and overhead.

The Teleplotter solves that problem. Plotting 40 points per minute, it is faster, cheaper, more accurate than manual plotting.

Vital data:

Plotting speed—40 points per minute, approximately 10 times faster than manual plotting
Plotting area—26 x 55 inches or less
Plotting accuracy—±.25 mm(paper stretch does not affect accuracy)
Scale factors—five factors, with independent selection for each axis
Plots X-Y data on linear or logarithmic paper
Time required to set up Teleplotter for operation—negligible

Applications:

Experimental uses
Plots wind tunnel data; static and structural test data; fractionating tower design data, etc.
Plots results of manual calculations and results of automatic electronic calculating machines to detect random errors.

Theoretical uses
Plots theoretical curves and results of theoretical calculations.

General uses
Plots insurance tables; stock market, statistical and financial records; production control data; results of engineering studies and analyses; management control data.
Plots results of continuous process operations for supervision and control purposes.

How it operates:

Data is introduced into the Teleplotter by IBM equipment or by the Teleplotter keyboard.
The Teleplotter Reading-Head, housing photo-electric "eyes," travels over the graph paper, counts grid lines and spaces, prints a symbol when its counts coincide with the IBM or keyboard data.

Write for brochure, "Automatic Data Analysis," giving full details on the Teleplotter and other Telecomputing Instruments. Coupon at right is for your convenience.

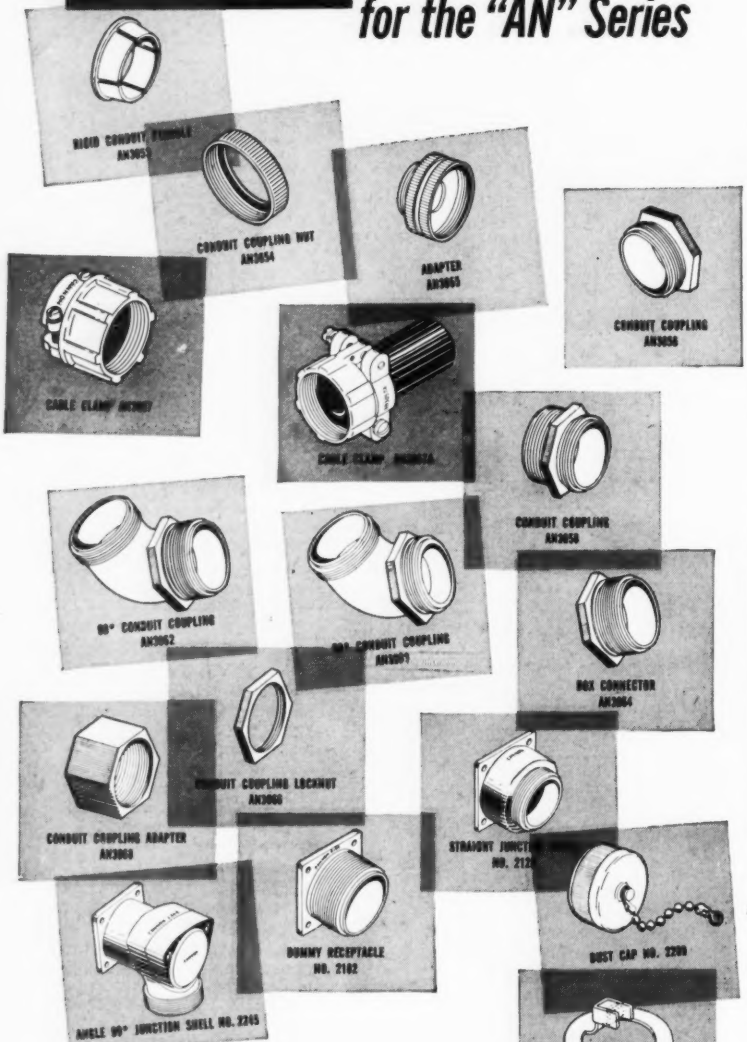
You are invited to visit Telecomputing's demonstration of its time-saving instruments at the National Instrument Exhibit in Cleveland, Sept. 8 - 12, Booths 829, 831.

Mr. Preston W. Simms, Engineering, Dept.—IS-8
Dear Sir: Please send me "Automatic Data Analysis."

Name
Company
Street address
City and State

TELECOMPUTING
CORPORATION, BURBANK, CALIFORNIA
"Turn hours into minutes with Automatic Data Analysis"

CANNON PLUG ACCESSORIES for the "AN" Series



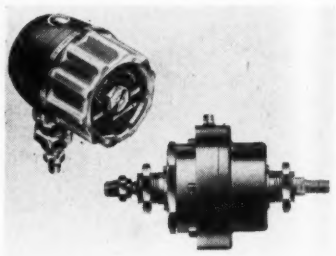
Here is the answer to a frequent question we receive from people everywhere. Yes, Cannon *does* make a complete line of accessories to be used in conjunction with the AN Series of connectors. Complete engineering data on each of these is given in the Cannon AN Bulletin, available on request.

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. H-180 P. O. Box 75, Lincoln Heights Station, Los Angeles 31, California.

NEW INSTRUMENTS

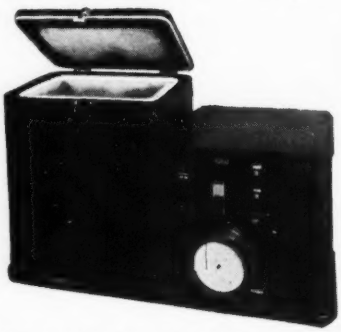


dirt, etc. Transmitters and receivers can be supplied in various combinations and mounting methods. Dials are calibrated as required: inches of water, psi., gpm., up-down distances, etc.—*Engineering Dep't, Farris Hydrotorque Corp.*, 610 *Commercial Ave., Palisades Park, N. J.*

Mention No. 937 when filling out card.

Low-temperature Tester

New "Sub-Zero Model R-70," is an industrial chilling machine suitable for testing procedures with temperature requirements of −10 to −80 F.; has a



chilling chamber 30 by 18 by 33 in. deep; thermal capacity 800 Btu's per hour at −70 F.—*Sub-Zero Products, Cincinnati* 29, *Ohio.*

Mention No. 938 when filling out card.

Bench Furnace

New "VK 7" bench type furnace, made for heat treating to 2000 F., has chamber dimensions of 10 x 6 x 18 in.; has embedded-design heating elements

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

of 6.5 kw capacity, at 220v. single phase, on all four sides of chamber and in door.—*Cooley Electric Mfg. Corp.*, 905 *Daly St., Indianapolis, Ind.*

Mention No. 939 when filling out card.

Combustion Tube Furnaces

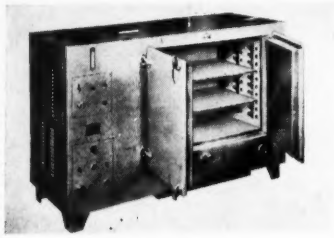
New "Type 70-T" and "Type 77-T" combustion tube furnaces use a 36-step tap-changing transformer mounted in pyramid base, making each furnace

and its controls one self-contained unit. Temperatures to 1950 F. Solid or hinged style.—*Hevi Duty Electric Co., Milwaukee* 1, *Wis.*

Mention No. 940 when filling out card.

Laboratory Oven

New "Con-Wate" is said to be the only mechanical convection oven which automatically provides constant air weight circulation at all temperatures,



and which automatically provides more cfm. as the temperature goes up. "Con-Wate" is said to out-perform all conventional units for general and analytical laboratory work, for preheating and aging, sterilizing, dehydrating and for drying and baking.—*Emil Greiner Co.*, 20-26 *North Moore St., New York* 13, *N. Y.*

Mention No. 941 when filling out card.

Spot Brightness Meter

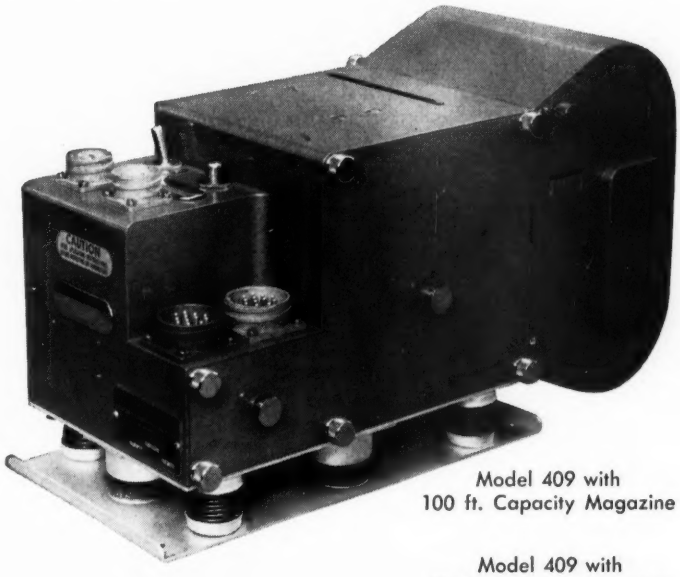
New "Spectra Brightness Spot Meter" measures brightness of a small area at any distance from four feet to infinity; consists of a vacuum photocell, amplifier and microammeter. Area measured is 1 degree, which means a 1-in. spot at 5 ft., a 2-in. spot at 10 ft., etc. Subject to be measured is viewed through telescopic sight, a circle in center of field of view indicating actual area being measured. Operator pushes a button when desired area is within

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Century MODEL 409

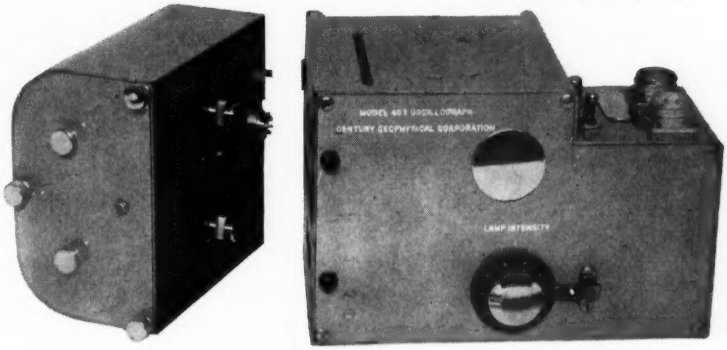
RECORDING OSCILLOGRAPH

FOR VIBRATION, TEMPERATURE, STRESS, STRAIN ANALYSIS



Model 409 with
100 ft. Capacity Magazine

Model 409 with
50 ft. Capacity Magazine



The Century Model 409 Oscillograph was designed for operation under the most adverse conditions and more especially, where space and weight considerations are limited.

This Oscillograph is the smallest and most compact unit available on the present market, yet it incorporates many features found in larger oscillographs, such as trace identification, trace viewing, continuously variable paper speeds and others. The Model 409 Oscillograph has been tested and proven to record faithfully during accelerations in excess of 20 g's. This makes it especially desirable for uses such as missile launching, parachute seat ejection, fighter aircraft and torpedo studies.

Write for Bulletin CGC-303 and CGC-301

Booth 408—I.S.A.—Cleveland

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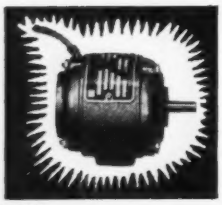
Century GEOPHYSICAL CORPORATION

TULSA, OKLAHOMA

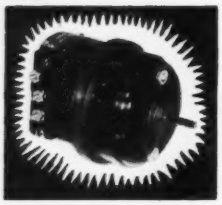
1505 Race Street, Philadelphia, Pa.
238 Lafayette St., Dayton, Ohio
EXPORT OFFICE: 149 Broadway, New York

WHEN YOU THINK OF *Instruments*
THINK OF **ELINCO**

SUB-FRACTIONAL MOTORS AND GENERATORS



BS FRAME



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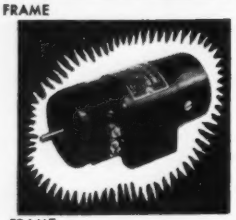
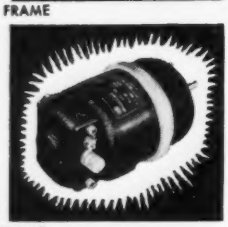


CB FRAME



FB FRAME

This time, try Elinco on that "special" problem of instrumentation. With hundreds of variations on over 600 basic models already manufactured, you may find that your special problem has been "pre-engineered" in the design files at Elinco. In tachometers, for instance, Elinco has developed countless high-precision variations of:

AC TACHOMETERS	DC TACHOMETERS
2-4-6-12 Poles	0.9 to 10 Volts at 100 r.p.m.
1-2-3 Phase	Voltage Output Linear
Standard Units	With Speed Within
Sine Wave Units	1% in Either Direction

SERVICES
1-, 2-, 3-, & 5-speed Synchronous
AC Dynamically Braked
Adjustable speed Governor-Controlled
Self-Starting
Reversible

FEATURES

Instrument-type precision ball bearings.
Every unit balanced dynamically . . . and *individually tested* under *specific load conditions.*
Ultra-precision manufacture of *all* parts.

PLUS
ANY physical or electrical variation to meet your specific requirements.
OVER 600 basic models with hundreds of variations already manufactured.

TYPES
AC • DC • Universal
Servo • Self-synchronous

RATINGS 1/3000 to 1/6 H P

PHASES One-, two-, and three-phase

WINDINGS
Compound • Shunt • Series
Separately Excited • Split Field
Permanent Magnet • Reluctance
Hysteresis • Stabilized Hysteresis
Induction • Drag Cup

PLEASE
. . . outline your problem in *full* detail when requesting quotations or literature. We have NO STOCK UNITS, no "mass-produced" units available. Every ELINCO unit is a precision instrument, specially designed and manufactured to meet your highest specific performance standards.

ELINCO

ELECTRIC INDICATOR CO.
CAMP AVENUE • SPRINGDALE • CONN.

NEW INSTRUMENTS

reticle circle and then releases it. Microammeter holds reading until button is again pressed. Total range, 1 to 1,000,000 ft.-Lamberts in five ranges; logarithmic scale.—*Photo Research Corp., 127 W. Alameda Ave., Burbank, Calif.*

Mention No. 942 when filling out card.

Centralized Combustion Safeguard System

New multiple-burner "Protect-O-Glo" system permits centralization of combustion safeguard equipment for 2 to 16

burners. System utilizes flame-rectification principle, features individual flame-detecting relays for each burner housed in a single cabinet which also houses push-buttons, signal lights and other component parts of safeguard circuit.—*Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 943 when filling out card.

Freezing Stage for Microscopes

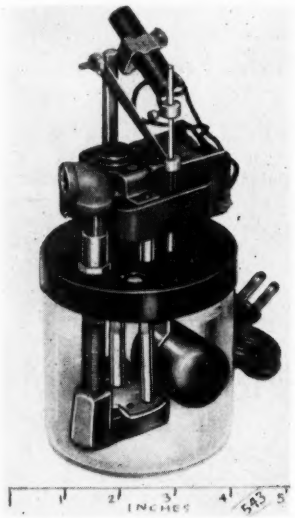
New "Kofler Micro Freezing Stage" (made in Austria) employs CO_2 to attain temperature of —40 C. within three minutes (—55 C. lowest); can be used with "Reichert" and other microscopes for observation of resins, oils, fats, etc. —*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

Mention No. 944 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Automatic Miniature Laboratory Pump

New automatically-controlled miniaure condensate pump is suitable for humidifiers, evaporative coolers, recirculating hot or cold water, and vari-



ous laboratory uses. One-pint jar is glass; pump is all-bronze; cover is plastic; entire outfit is rust-proof. Float and mercury switch start and stop pump automatically. Capacity at zero lift, 75 gph.; at 3-ft. lift, 10 gph.—*Pump Div., Samuel S. Gelber Co.*, 162 *N. Clinton St., Chicago* 6, *Ill.*

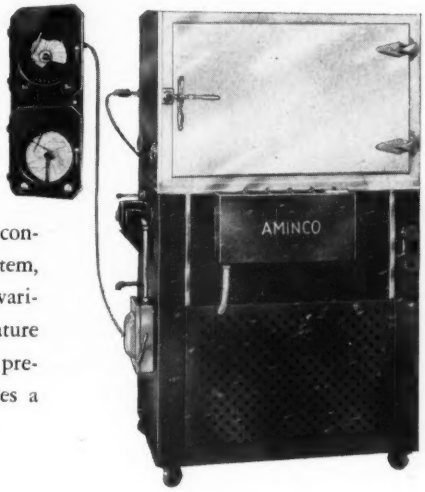
Mention No. 945 when filling out card.

Thickness-tester Fixture

New magnetic fixture for ultrasonic "Audigage" thickness tester holds searching unit against plate being tested; assures good contact; prevents

AMINCO

CLIMATE-LAB HUMIDITY-TEMPERATURE TEST APPARATUS *With Program Control*



The Climate-Lab is of great utility in testing the performance and durability of materials and devices under specific climatic conditions.

It consists of a test chamber, air-conditioning unit, and control system, which affords precisely controlled variations of humidity and temperature repeated periodically according to predetermined programs, and provides a chart record of these variations.

Program Schedules Available

Stock cams are available to perform the following humidity-temperature cycles required under the following Armed Forces specifications:

JAN-C-20	JAN-C-76	JAN-M-745	MIL-E-5272 (USAF)4.4.1,Proc.I
JAN-C-25	JAN-C-91	JAN-R-19	MIL-E-5272 (USAF)4.4.2,Proc.II
JAN-C-62	JAN-C-372	JAN-R-26A	MIL-E-5272 (USAF)4.4.3,Proc.III
	JAN-I-6		MIL-M-745A (Proposed)

SC-D-16286-B — USAF Spec. 41065-B, Grp. 30, Method 31.

ES-D-65103-A — Pre-conditioning state of 50% relative humidity and 77°F. (applies to many standard cycles).

Cams for other humidity or temperature programs are available.

Four Types of Humidity-Temperature Control

1. Constant humidity and constant dry-bulb temperature.
2. Constant humidity and varying dry-bulb temperature.
3. Varying humidity and constant dry-bulb temperature.
4. Varying humidity and varying dry-bulb temperature.

Partial List of Users

American Tobacco Co.
Bausch & Lomb
Bell Telephone Laboratories
Bendix Corp.
Colgate-Palmolive-Peet Co.
Ford Motor Co.
General Electric Co.
Standard Brands
U. S. Steel Corp.
U. S. Testing Co.
Mellon Institute
University of Missouri

U. S. GOVERNMENT:
Army Air Corps
Army Chemical Corps
National Bureau of Standards
Naval Powder Factory
Rock Island & Redstone Arsenals
Veterans Administration

Write for Bulletin H-2196

AMERICAN INSTRUMENT CO., INC. AMINCO **Silver Spring, Maryland**

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

THE LOGRINC DIGITAL GRAPH PLOTTER automatically plots one variable against another algebraically in incremental steps, in response to electrical impulses. It is ideally adapted for use as a read-out device for electronic digital computers, especially digital differential analyzers, and for use in connection with such problems as aircraft tracking and automatic data reduction.

- plots at speeds up to 20 steps per second, in incremental steps of 1/64 of an inch.
- simultaneous movement on both axes in either direction.
- can be controlled electronically or by external or remote switches or relays.
- will make several carbon copies or duplicating stencil.
- instant manual positioning of pen and drum.
- takes 12" x 18" paper or continuous 12" strip.

Mechanical simplicity . . high reliability . . digital accuracy . . quick pen cartridge change . . self-contained power supply.

Additional information supplied on request.

LOGISTICS RESEARCH COMPANY

141 South Pacific Avenue
Redondo Beach, California

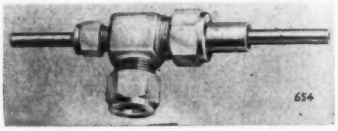
NEW INSTRUMENTS

accidental shifting of searching unit during tests; permits one man to operate instrument.—*Branson Instruments, Inc.*, 430 *Fairfield Ave., Stamford, Conn.*

Mention No. 946 when filling out card.

Instrument-tube Fitting

New "Swagelok Heat Exchanger Tee" is available in brass, aluminum, steel, stainless steel and Monel, for steam jacketing or temperature control of process lines where it is necessary to

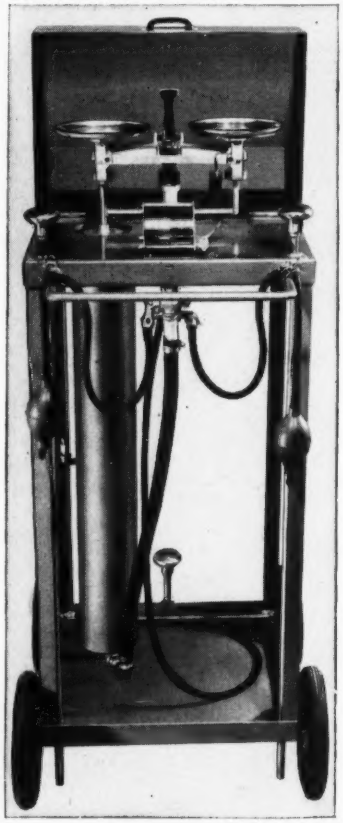


effect heat exchange between coolants and process fluids. Small end has been bored through fitting to allow tube to pass completely through jacketed end. Sizes: up to 1 in. O.D. for jacketing tube.—*Crawford Fitting Co.*, 884 *East 140th St., Cleveland* 10, *Ohio.*

Mention No. 947 when filling out card.

Pneumatic-instrument Calibrator

New transportable unit for calibration and testing of low-pressure (0-20 in. water) measuring and controlling instruments is made available after its prototype has been used for years in maker's own production line. It is



Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

easier to use and more accurate than water column manometers, especially for extremely low pressure calibration; accurately measures pressure, differential, or vacuum, in increments of 0.01 in. of water (0.000036 psi.). Essentially a manually-operated force-balance, calibrator consists of a standard chemical equal-beam weight-scale and an oil-sealed bell. Weights on one scale pan are balanced against an opposing air pressure in bell. Thus, bell air pressure can be determined with laboratory scale accuracy.—*Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.*

Mention No. 948 when filling out card.

Industrial Refractometer

New high-speed industrial refractometer designed for production-line use by workers with only ordinary training is accurate to plus or minus 0.0001;

requires no adjustment, has no moving parts. Analyses of most products can be made in 10 to 15 seconds. Each refractometer is tailor-made to any one of seven specific ranges which are built into instrument to user's specification. According to scale selected, instrument will give readings in terms of refractive index, percentage of dissolved solids, or Butyro number.—*Bausch & Lomb Optical Co., Rochester, N. Y.*

Mention No. 949 when filling out card.

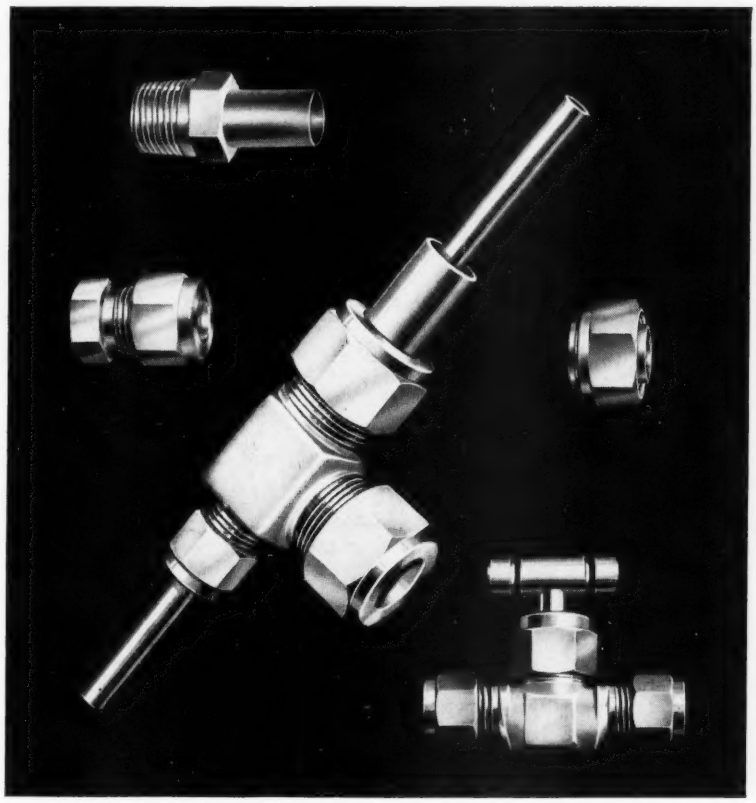
Wide-angle Lens

New "Metrogon" photographic lens enables a single aerial photograph to show three times as much area as was previously possible from same altitude. It combines extremely wide angle (90 deg.) with sharpness and freedom

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

NEW Swagelok®

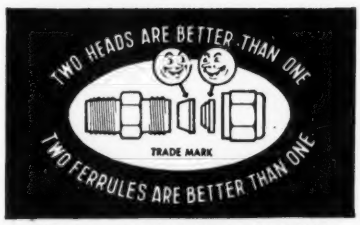
FITTINGS TO MAKE YOUR WORK EASIER



Visit our Booth

Be sure to stop at Booth 432 at the Instrument Exhibit. Our Engineers will be glad to discuss your problems and demonstrate the superior qualities of Swagelok Fittings.

SWAGELOK FITTINGS AVAILABLE IN: BRASS, ALUMINUM, STEEL, STAINLESS STEEL, MONEL



COME TO YOU COMPLETELY ASSEMBLED, FINGER TIGHT

Crawford can give you an engineered solution for every tube fitting problem. For proof—just look at the new additions to the Swagelok line. There are Plugs, Caps, Adapters, Heat Exchanger Tees and Instrument Air Valves. All are designed to make your work easier.

Every Swagelok Fitting gives you a leak-proof seal with one and one-quarter turns. No torque is transmitted to the tubing in assembly. Can be used on heavy or thin wall tubing. Connections are simple and fast. All these advantages are yours when you standardize on Swagelok.

CRAWFORD FITTING CO.
884 E. 140 ST., CLEVELAND 10, OHIO

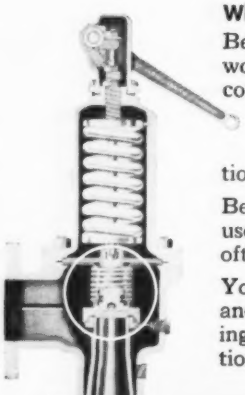
Stuck without WARNING

Who's stuck?

Safety valves that weren't safe? The plant which installed them?

None of this was necessary. If you want 100% safety—and you'd hardly want less—there's one sure way to get it—specify BalanSeal or FarriSeal Valves.

Why?



Because they *can't* stick, plug or corrode. Critical working parts are permanently isolated from any contact whatever with the lading.

Because they're unaffected by back pressures in the discharge manifold due to its own operation or to the opening of other valves in the line.

Because these features make it possible for you to use smaller discharge piping, an economy which is often substantially more than valve cost.

You'll be interested in the engineering of BalanSeal and FarriSeal Valves—design which is rapidly gaining acceptance in hundreds of successful installations.

Ask for our "8-Minute Brief."

Your Safety's REAL With FarriSeal

Farris ENGINEERING CORP.

610 COMMERCIAL AVE., PALISADES PARK, N. J.

1198

SEE US AT BOOTH 209, 211 & 213 INSTRUMENTS SHOW—CLEVELAND

NEW INSTRUMENTS

from distortion at relatively high speed of f:6.3; and has a focal length of 5.25 in. So clear is its definition that a photo from an altitude of a mile can show separate railroad ties anywhere within a two-mile radius beneath plane.—*Bausch & Lomb Optical Co., Rochester, N. Y.*

Mention No. 950 when filling out card.

Leak Detecting System

New "Model TFS4-B90 Raymaster" black-light exploring-lamp equipment permits easy detection of leaks in power-plant condensers and other vessels.

An extremely dilute solution of fluorescing agent ("Type GPC" for water, "Type 5GA" for oils) is placed inside vessel to be tested. Check for leaks is made in a darkened area; lamp is moved near joints and other suspected spots; leaks show unmistakably by brilliant glow of seeping liquid.—*George W. Gates & Co., Franklin Square, L.I., N. Y.*

Mention No. 951 when filling out card.

Counter for Weissenberg Goniometer

New Geiger-counter attachment for Weissenberg goniometers is designed for use as an attachment to Weissenberg cameras used in conjunction with

counting circuits and recorder as employed with Philips X-ray Spectrometer.—*Research & Control Instruments Div., North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.*

Mention No. 952 when filling out card.

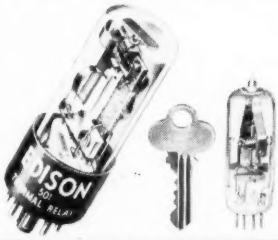
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Condensed Indicating-warning Instrument Display

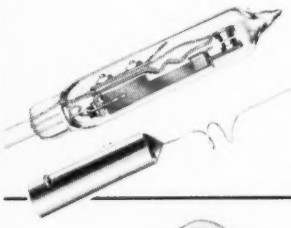
New "Glowmeter" condensed indicating-warning system is said to combine Instrumentation with Optics approached from human engineering standpoint. Any instrument mechanism may be adapted to new system by substitution of a colored miniature transparent disk for pointer and dial; disk bears same or finer graduations and numerals. A low candle-power light source projects a beam of light through a condenser lens, a portion of disk periphery, and an objective lens to a remote screen whose optical qualities are such as to render it immune to natural or artificial light of equal intensity. Numerals and calibrations ap-

pear as a segment of an arc of sufficient width to permit rapid recognition of increases or decreases in indicated value centered on an index point: this represents "condensed" feature of system. Transparent disk rendered in contrasting colors provides "warning" feature by changing background color at established points on scale. Any colors may be used. For military applications, numerals are red on a black background for normal conditions, changing to black on a red background for abnormal conditions. Degree of abnormality is shown by amount of red background moving into display from left to right. Reading distance is several times greater than with conventional opaque black-and-white displays with numerals of equal size. Regardless of size of instrument mechanism, each display may be as small as 0.5 x 1.0 in., yet be clearly visible under all light conditions from a distance of six feet. Thus 15 displays may be concentrated in an area 5 x 7 in. System is claimed to offer to industry "an entirely new concept of panelboard instrumentation," with unique advantages: Reduction in panelboard (scanning) area of between 75 and 90 percent. Clarity of definition speeds readings and minimizes errors. Red-background warning may be quickly de-

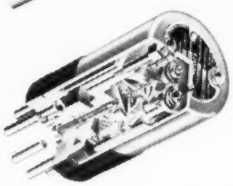
EDISON
AUTOMATIC CONTROL COMPONENTS



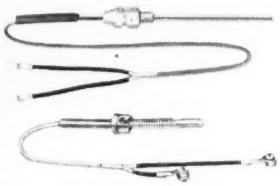
EDISON THERMAL TIMING RELAYS. Complete range of time delays from 2 seconds to 300 seconds within tolerance of ± 15% guaranteed for full life of relay. Standard RMA heater voltages. Both standard size and miniature relays meet shock, vibration and environmental requirements for aircraft application. Ask for free bulletins #3007 and 3027.



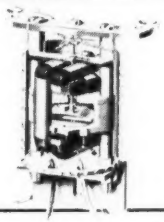
EDISON SEALED THERMOSTATS. Sealed-in-glass types break 115 volt 8 ampere *direct current* load with practically no contact arc. Type S1-1A holds control point within ± 0.1° over years without drift or apparent wear. Contacts cannot film or become contaminated even after years of inactivity as in fire alarm service. Write for free bulletin #3009.



EDISON SENSITIVE MAGNETIC RELAYS. SPST or SPDT contact arrangement—operate directly from d.c. current as low as 75 micro-amps. Contacts carry ⅓ amp non-inductive load. Copper-wound coils absorb overload to 10,000 times rated power. Separate coil leads to pins permit series or differential hookup. Send for free bulletin #3004.



EDISON ELECTRICAL RESISTANCE BULBS include the standard MIL approved types for aircraft and a wide variety of bulbs for industrial temperature alarm systems, hot bearing detection and process control applications. Latest bulbs are permanently sealed, require no maintenance. Free bulletin #3016.



EDISON RATIO MOVEMENT. A sensitive, rugged moving-magnet fixed-coil galvanometer developed primarily for use with the EDISON bridge as a temperature indicator free of voltage error. It may be used wherever an indication proportional to the ratio of two quantities, transferable into electrical terms, is required. For further information, write details of your requirements.

Visit the EDISON EXHIBIT at the
INSTRUMENT SOCIETY SHOW • Cleveland — Sept. 8-12

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21 Lakeside Avenue, West Orange, New Jersey

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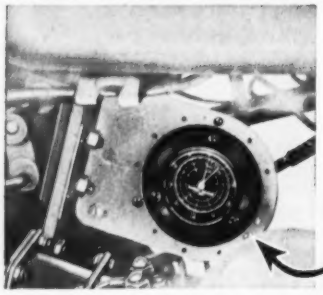
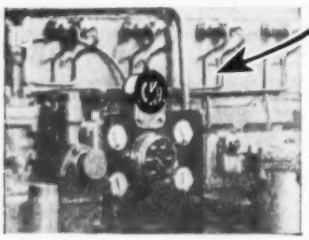


Photo Below Courtesy Cummins Engine Company, Inc.



Seventh National Instrument Exhibit September 8-12, 1952 Booth No. 706 Cleveland Auditorium, Cleveland, Ohio

The Sure Way to "Design out" Vibration and Shock Damage.

Lord Meter Mountings are paying dividends to manufacturers and users of heavy duty industrial and farm tractors, lift trucks, stationary engines and many other industrial machines where shock and vibration are encountered.

The Lord Meter Mount assures the accurate performance designed into Hobbs Engine-Hour Meters when they are subjected to excessive vibration on farm tractors and stationary diesel engines. These meters are protected from the damaging effects of vibration and shock by the unique method of combining shear and rolling action of the rubber to absorb destructive forces. The outer ring is mounted to the panel and the inner ring holds the meter thus giving protection in multi-planes. The rubber between these rings does the work. We will be pleased to have the opportunity to help you in the application of Lord Meter Mountings.

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LORD BONDED RUBBER

HEADQUARTERS FOR VIBRATION CONTROL

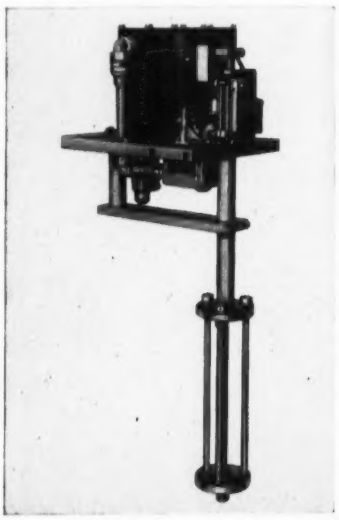
NEW INSTRUMENTS

tected as it creeps into display, without need for direct viewing. In large-scale industrial applications a photo-recording or televised display may be installed.—*Glowmeter Corp., 37 Franklin St., Buffalo 2, N. Y.*

Mention No. 953 when filling out card.

Non-clogging Primary Element for Viscometer

New "Viscometer" Measuring Element, for solutions that build up a coating that normally interferes with accurate measuring of viscosity by in-



dustrial "Viscometers," is particularly suitable for process-control applications where these solutions tend to solidify when exposed to air.—*Dep't N27, Norcross Corp., Newton 58, Mass.*

Mention No. 954 when filling out card.

Motor Speed Controller

New "Type 1702-A Variac Speed Control," for commanding a ¼-hp. motor, uses no electronic tubes and so takes

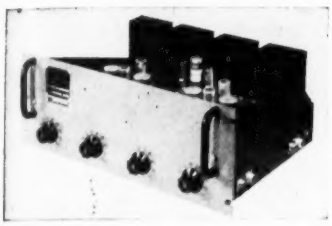
no warm-up time. Instant starting and reversing; strong dynamic braking. Construction and circuit similar to those of earlier smaller units.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

Mention No. 955 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Stabilized Amplifier

New "Type 2173-2A1" stabilized capacitor-coupled amplifier, for frequency range of 0.1 to 50,000 cps, was originally developed for special application;

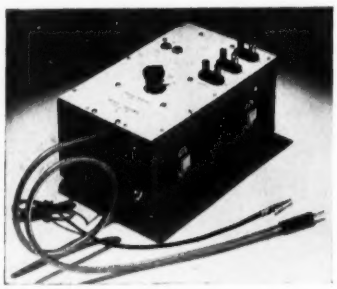


is recommended for geophysical, electromedical, industrial-control, and other uses. Maximum output, 15 volts (rms); gain, feedback-stabilized, adjustable in 10-db steps from −20 db to +60 db.—*Engineering Research Associates, Inc., 1902 W. Minnehaha Ave., St. Paul 4, Minn.*

Mention No. 956 when filling out card.

Instrument Amplifier

New "Model 102 Phantom Repeater" incorporates several refinements. Input impedance is now greater than 200 megohms shunted by 6.0 uuf.,



and output impedance is within 350 ohms in series with 8 uf. Features include gains of 1.0, 10, and 100; frequency response of 5 cps. to over 150,000 cps. Manufacturer states that accuracy of many measurements is greatly increased by use of improved instrument. Examples include connecting a voltmeter or oscilloscope to a high-impedance test circuit through "Phantom Repeater" to avoid usual losses.—*Keithley Instruments, 3868 Carnegie Avenue, Cleveland 15, Ohio.*

Mention No. 957 when filling out card.

Sweeping Oscillator and Signal Generator

New "Deca-Sweep" is a combination high-frequency decade-switched sweeping oscillator and signal generator; eliminates tedious point-by-point measurements of high frequencies; provides visual display of band pass character-

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

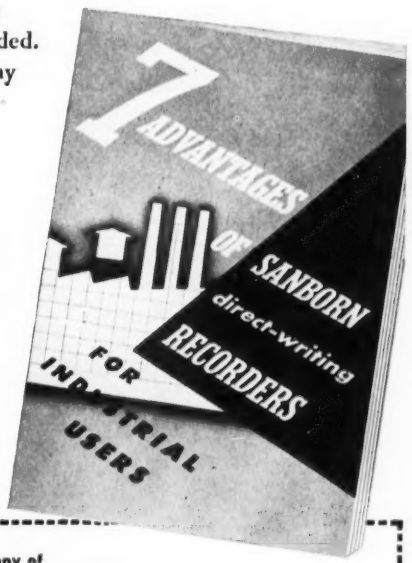
ILLUSTRATING ONE REASON WHY

You can't beat the system

WHEN IT'S A

SANBORN Recording System

SANBORN records are *inkless* and *permanent.* They are produced by a *heated stylus ribbon* which melts the heat-responsive, plastic-coated surface of the recording paper (Sanborn Permapaper). The result is a clear, sharp tracing showing *fine* details of the phenomena being recorded. This is just *one* of many **SANBORN** advantages.



Learn MORE about SANBORN in a new, interesting, and pertly illustrated 16 page booklet, "7 Advantages of Sanborn Recorders for Industrial Users." Send for your copy today.

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SANBORN CO. **INDUSTRIAL DIVISION CAMBRIDGE 39, MASS.**

New POTTER *Electronic* FLOWMETER *and* TACHOMETER

Improved design eliminates

★ BEARING MAINTENANCE
★ HIGH PRESSURE DROP
★ BEARING FRICTION

The improved Potter Electronic Flowmeter (patent pending) combines extreme accuracy with freedom from maintenance. This new design eliminates thrust bearings, high pressure drop, and bearing maintenance.

The Potter Flowmeter comprises a flow sensing unit having a hydraulically balanced rotor and magnet rotating within a compact non-magnetic housing, and an external pickup coil connected to an electronic integrator or totalizer, or both.

ACCURATE within ±½%

Since the novel, high-efficiency rotor spins in a freely balanced position within a venturi, its blades operate with practically no slippage. Fluid viscosity, pressure, temperature, and specific gravity only slightly affect the volumetric flow rate. Accuracy is maintained within ±½%. Electric impulses from the rotor can be conducted to a combination electronic integrator and totalizer or other instrumentation. Rate of flow can be read or recorded either directly or remotely, and total flow is indicated on a resettable magnetic Veeder-Root counter.

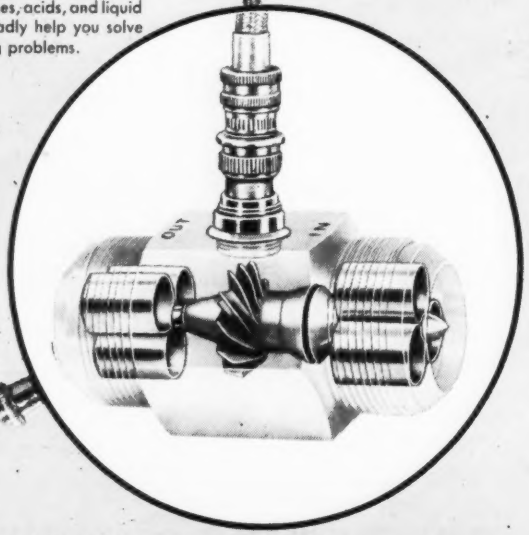
Equipment is available with specific gravity compensation adjustment.

POTTER Airborne FLOWMETER

Potter Single Range Airborne-type Flowmeter installation is compact and light in weight. Total weight of ¾ in. sensing element, integrator with dust cover, and indicator operating on 115 volts ac, 400 cycles, is only 4⅞ lbs. Equipment operating on 24-28 volts dc also available.

APPLICATIONS

Potter Flowmeters accurately measure flow. Especially suitable for highly corrosive liquids, gases, acids, and liquid oxygen. We will gladly help you solve your flow measuring problems.



SEND FOR NEW BULLETIN 1050

which gives full information, pressure drop chart, ranges, sizes, and operational data.

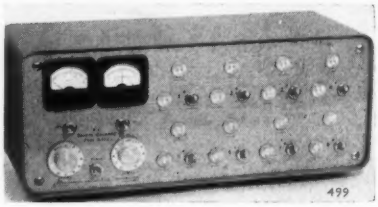
POTTER AERONAUTICAL CO. 87 Academy Street, Newark 2, N. J.

istics for observation and measurement with 'scope. (1) Sweeping Oscillator frequency range 10 kc. to 1 Mc.; center frequency decade-switched in 1-kc. steps; sweep width continuously variable from 0 to 15 kc.; amplitude response flat within better than 5 percent. (2) Signal Generator frequency range 10 kc. to 1 Mc.; frequency control decade-switched in 1-kc. steps; frequency accuracy 0.1 percent at maximum frequency, short term stability 50 cps.; harmonic content less than 3 percent.—*Decade Instrument Co., Caldwell, N. J.*

Mention No. 958 when filling out card.

Bridge Balance for Recorders

New "Type 8-108" 8-channel Bridge Balance may be used for direct recording of output of a wide variety of strain gages and strain-gage type pickups without use of amplifiers. Up to eight 120- to 350-ohm pickups, comprising four active arms, may be connected to instrument. If fewer active arms are



used, dummy gages can be easily added externally. Voltage across each bridge can be adjusted individually and continuously from the level of the supply voltage (28.5 volts d.c. maximum) down to a minimum of 2.0 volts on a 350-ohm 4-arm bridge and 1.1 volts on a 120-ohm 4-arm bridge. Each channel is provided with its panel voltage control, and channel selector switch connects any desired channel to voltmeter circuit. Individual voltage adjustments allow pickups of different resistance value to be used simultaneously while maintaining optimum wattage dissipation on each. Drift problems are thereby minimized.—*Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.*

Mention No. 959 when filling out card.

Phase Meter

New "Type 404 Advancetron" phase meter is said to be first commercially-available instrument giving direct read-

ing in degrees between two alternating voltages of any waveform (rectangular, sinoidal sawtooth, symmetrical or not) from 100 kc. to 0.—*Advance Electronics Co., P. O. Box 394, Passaic, N. J.*

Mention No. 960 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Dip Meter

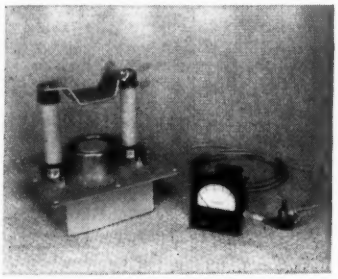
New "Model 600 Dip Meter," for measuring resonant circuit characteristics, has a wide range of applications as a grid dip oscillator, absorption wave

meter, auxiliary signal generator, and r-f. signal monitor; also provides a calibrated means of identifying spurious emissions and their sources; has a calibrated frequency range of 1.75 to 260 Mc. in 5 overlapping bands.—*Barker & Williamson, Inc., 237 Fairfield Ave., Upper Darby, Penna.*

Mention No. 961 when filling out card.

Radio-frequency Voltmeter

New voltmeter measures rms. values of rf. voltages in dielectric heating loads; obviates need of trial-and-error methods of electrode adjustment; con-

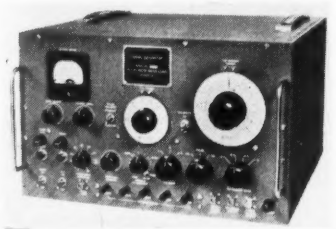


sists of a capacitance voltage divider and a crystal rectifier, connected to an indicator calibrated in kv. No external power required for operation other than less than 0.1 watts taken from rf. voltage source. Two scale ranges: 0-5,000 and 0-10,000 volts. Frequency ratings available: 200 to 3,000 kc. and 3 to 50 Mc.—*Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.*

Mention No. 962 when filling out card.

Swept-signal Generator

New signal generator, said to combine all functions normally required in IF. amplifier work, consists of four instruments: (1) signal generator cover-

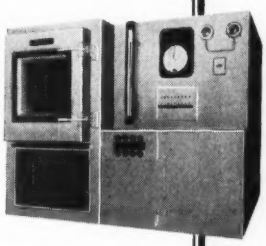


Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

temperatures! atmospheres! pressures!

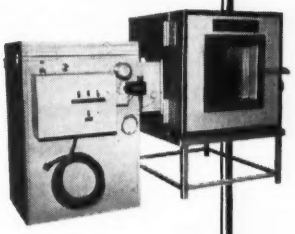
For ACCURACY TEST WITH Tenney

. . . for Tenney Test Chambers are precision-engineered for maximum efficiency and can be designed to simulate the complete range of temperature, atmospheric or pressure conditions found anywhere on earth—or above it to altitudes of 120,000 ft. plus! They attain sub-zero temperatures quickly, maintain them efficiently and provide full instrumentation for accurate evaluation of complete test data.



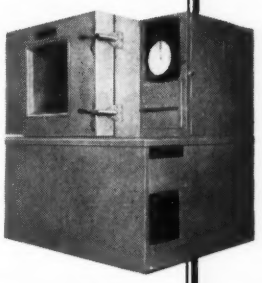
TENNEYZPHERE ALTITUDE CHAMBERS

Designed to withstand atmospheric pressure and to simulate global conditions of pressures, temperatures and humidities. Altitudes from sea level to approx. 80,000 ft. Temperature range from plus 200°F to minus 100°F. Also simulates desired (20% to 95%) relative humidity.



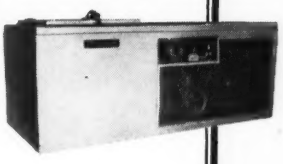
TENNEY SERVO UNIT

Portable air conditioning unit which may easily be attached to various types of laboratory enclosures—impact machines; tension machines; torsion testers; cold boxes and similar equipment. Through its use, articles undergoing testing, aging or weathering can be subjected to wide variations of humidity, heat and cold. Photo shows servo attached to companion chamber.



TENNEY TEMPERATURE AND HUMIDITY CHAMBER

Designed for positive control of temperature, humidity and air circulation. Permits the accurate checking of physical quality, fragility, tension and other factors. Also built to incorporate extreme low temperatures, to −100°F.



TENNEY SUB-ARCTIC INDUSTRIAL CABINETS

Designed for low-temperature testing of metals, radios, instruments, plastics, liquids, chemicals and pharmaceuticals. Temperature ranges of −40°F, −60°F, −95°F and −150°F are standard for each size.

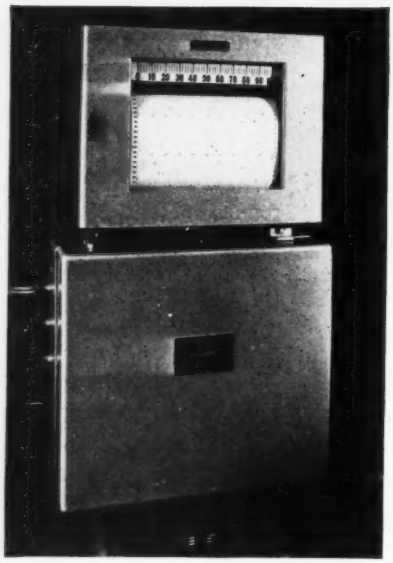
For further information on these and other Tenney test equipment, write to Tenney Engineering, Inc., Dept. B, 26 Avenue B Newark 5, New Jersey.

Tenney

Engineers and Manufacturers of Automatic Environmental Test Equipment

Reliably Accurate

UNDER PLANT CONDITIONS



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PLANT STREAM ANALYZER

- **trace monitoring**
- **separation control**
- **composition cost accounting**
- **synthesis control**
- **stream blending**

Plant stream analysis by continuous infrared-absorption methods has proved itself to be a decisive factor in the economic success of processes involving chemical, petro-chemical, and petroleum-derived streams.

The Process Controls Plant Stream Analyzer has proved itself to be the instrument for the job — with high sensitivity, rapid response, rock-solid stability, explosion-proof design, complete reliability under the most rugged conditions, and adaptability to an unlimited range of applications.

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You can hear it described — in theory and in application, by our engineers who will conduct several of the classes in the Analytical Instruments Clinic to be held concurrently with the Show.

You can discuss your problems of plant stream analysis — with our engineers who will be available at all times during the Show, to help you with any questions you may care to bring up.

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NEW INSTRUMENTS

ing 4.5 to 95 Mc. at 0.25 percent accuracy, with calibrated output to ½ volt rms.; (2) wide-range swept-frequency generator covering center frequencies from 7 to 70 Mc. sweep width continuously adjustable; (3) precision frequency marker generator covering full swept range, accurate to 0.25 percent providing a unique vertical line marker sharply defined for deviations; (4) pulsed RF signal generator covering 4.5 to 95 Mc. range with internal pulse amplifier for introduction of external pulse modulation, output to ½ volt peak-to-peak, rise time 0.1 microsecond. Additional features include an internal crystal calibrator, sweep voltage output for 'scope, variable and fixed-step push button attenuator calibrated over a 100-db range, and a complete accessory cable complement.—*Avion Instrument Corp.*, 299 *State Highway* 17, *Paramus, N. J.*

Mention No. 963 when filling out card.

Low-capacitance Standards

New "Model 388" set of secondary standards of low capacitance comprises two "T" networks, three auxiliaries, and a set of connecting cables. Nominal values of networks are 0.075 and 7.5 uuf.; auxiliaries modify networks so that values of 0.001, 0.0075, and 0.75 uuf. can be obtained. All elements have Q of 200 or better and temperature coefficient of less than 0.05 percent per degree C. The true values are within 5 percent of nominal values; Bureau of Standards certification can be furnished at extra charge.—*Mac Leod and Hanopol, Inc.*, 10 *Roland St., Charlestown* 29, *Mass.*

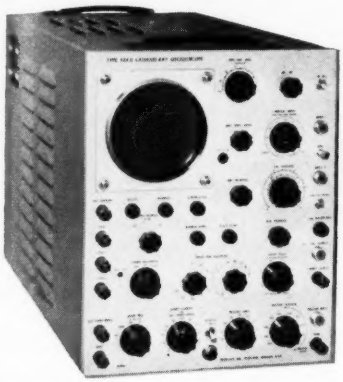
Mention No. 964 when filling out card.

Television Oscilloscope

New "Type 524-D" Oscilloscope meets needs of TV broadcasters in adjusting and maintaining transmitters and studio equipment; is a precision lab 'scope with specialized TV features, among which: (1) Variable sweep delay circuit provides a zero to 25-millisecond delay. (2) Delayed sweeps, triggered by any line sync pulse throughout picture, are available through entire sweep range of 0.01 sec/cm to 0.1 microsec/cm. (3) Field Selector. (4) Internal sync

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

separator. (5) In new sweep magnifier, center of sweep remains fixed and sweep is expanded to right and left of center; magnifications of 3x and 10x permit detailed examination of sync and equalizing pulses. (6) Internal time mark

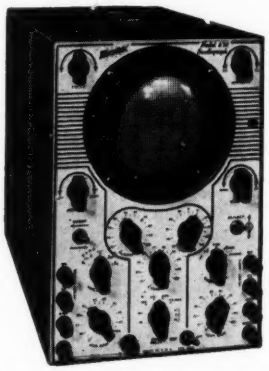


generator modulates trace brightness; Pips spaced 1, 0.1, 0.05 microsecond and 200 pips per TV line available. (7) Variable-duty-cycle square wave, accurate within 3 percent, calibrator continuously variable through 7 ranges from 0.05 to 50 v., duty cycle adjustable from 1 to 99 percent.—*Tektronix, Inc., P.O. Box* 831, *Portland* 7, *Oregon.*

Mention No. 965 when filling out card.

Five-inch Oscilloscope

New "Model 670" 5-in. oscilloscope permits visual testing and alignment of AM and FM receivers, and TV equipment, when used with a frequency-mod-



ulated rf. oscillator or sweep generator. Contains d-c. amplifiers to provide excellent square-wave response on both high and low frequency. Sensitivity of 10 millivolts rms. per inch permits proper viewing of TV response curve even on receivers that are far out of alignment. Recent-design astigmatic focus control is said to provide a new standard in trace sharpness.—*The Hickok Electrical Instrument Co.,* 10519 *Dupont Ave., Cleveland* 8, *Ohio.*

Mention No. 966 when filling out card.

Oscillograph Accessories

New accessories for GE "PM-18" portable magnetic oscillograph include: (1) continuous-drive film holder for applications which require a longer record than can be obtained with either film-pack or Polaroid Land film holder;

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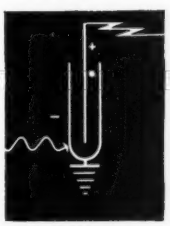
OF AN INCH?

NEW **ohmart**

NULL-TYPE MEASURING SYSTEM

utilizing radioactivity, will do this and many other measurement feats you may have thought virtually impossible! At the Cleveland instrument show you will be able to see it work—learn how it performs gas analysis, indicates interface liquid level measurements, measures surface films without contact with the material being measured—and with unheard-of simplicity, amazing accuracy!

SOMETHING NEW HAS BEEN ADDED TO THE SCIENCE OF MEASUREMENT—PLAN TO SEE IT AT BOOTH 616—SEVENTH NATIONAL INSTRUMENT EXHIBIT, CLEVELAND—SEPTEMBER 8 THROUGH 12.

ELECTRICITY  FROM RADIOACTIVITY

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For use wherever precision measurements are required in shop inspection or layout procedures.

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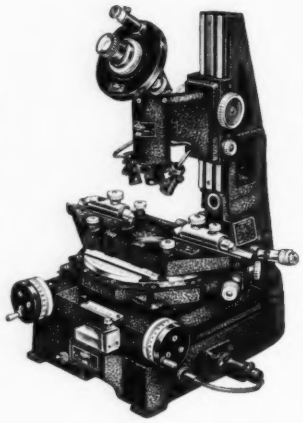
Coordinate Measurements
Left to Right .....100 mm or 4 inches
Front to Rear ..... 50 mm or 2 inches

Direct Reading to ..0.002 mm or 0.0001 inch

Angular Measurements

Stage Range	360°
Reading with Vernier	1 min.
Protractor Circle Range	360°
Reading with Vernier	1 min.
Magnification	30X
Microscope Column Tilt	±8°



- **Detects errors in cutting tools.**
- **Checks threads and thread gages.**
- **Measures critical dimensions on machine and instrument parts.**
- **Adaptable to flat work, round work, odd shapes.**

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NEW INSTRUMENTS

(2) viewing attachment for users who wish to observe wave-form before taking a record; (3) galvanometer with sensitivity of 1.67 mm./ma. at one me-

ter; and (4) sweep mirror which provides adjustable time sweep of 0.1 to 0.5 seconds in addition to original non-adjustable 1/60-second sweep.—*General Electric Co., 40 Federal St., West Lynn 3, Mass.*

Mention No. 967 when filling out card.

Monitor Kinescope

New "10 SP4" directly-viewed 10-inch cathode-ray tube for monitor service in connection with theater-TV, industrial TV and studio broadcast equipment, features an electron gun designed with an acceleration type of electron lens to provide high resolution and good uniformity of focus over entire picture area.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

Mention No. 968 when filling out card.

Ground-resistance Tester

New "Model JP" of maker's "Ground-Ohmer," for earth resistance measurements for power circuits and soil investigation, operates on potentiometer or drop of potential principle; incor-

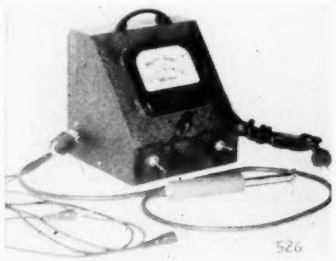
porates an a-c. magneto generator of hand-cranking type. Two variations available: one for testing earth of high-tension lines, lightning arresters, etc., the other for investigating soil conductivity on building sites, etc.—*Herman H. Sticht Co., 27 Park Place, New York 7, N. Y.*

Mention No. 969 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Motor and Circuit Tester

New "Harvlie-Boyce Indicator," for testing electromagnetic circuits, operates on 110-volt 60-cycle supply. It obviates need for test lights, compass, battery, growlers, etc. When analyzing a

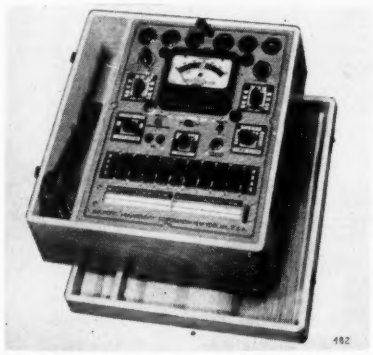


motor, location and nature of trouble can be quickly found. Polarity, flux pattern, relative strength or other characteristics of coils may be determined whether they are on stator or armature. Phase sequence of polyphase motors is indicated. Inexperienced personnel soon become proficient trouble-shooters.—*H-B Indicator Co., 915-B Terminal Sales Bldg., Seattle 1, Wash.*

Mention No. 970 when filling out card.

Tube Tester

New "Model 206" mutual conductance tube tester gives microhmo readings for all amplifier tubes, tests cold-cathode, magic-eye, voltage-regulator

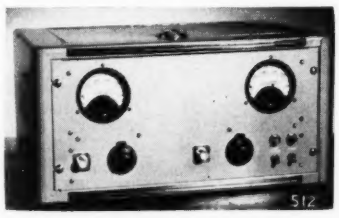


and ballast tubes, from 0.75 volts to 117 filament volts. All present and future tubes can be tested.—*Electronic Measurements Corp., 280 Lafayette Street, New York, N. Y.*

Mention No. 971 when filling out card.

Dual High-voltage Supply

New "Model 80" consists of two individually-regulated high-voltage low-current sources; was designed for coincidence counting, etc. Among features: a ten turn "Helipot" for accurate voltage settings; high-voltage



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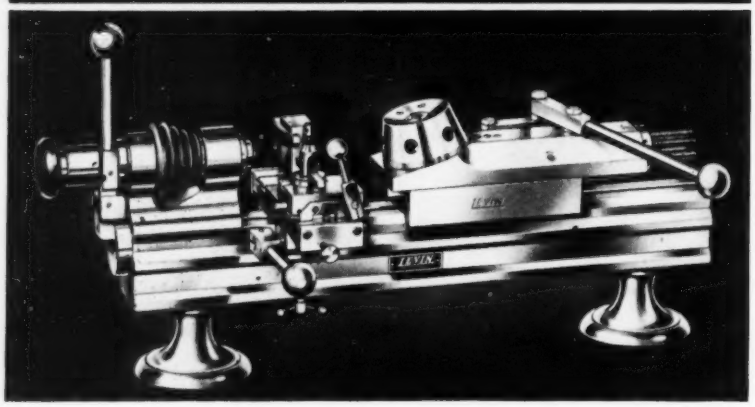

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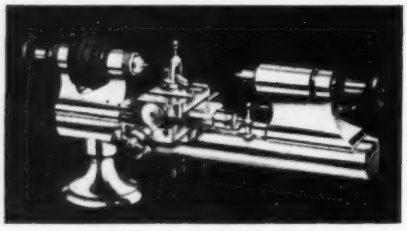

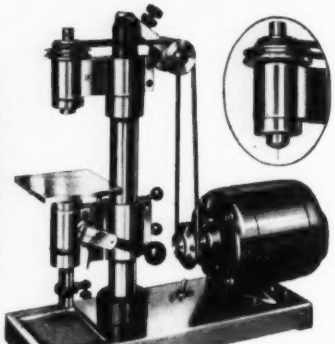

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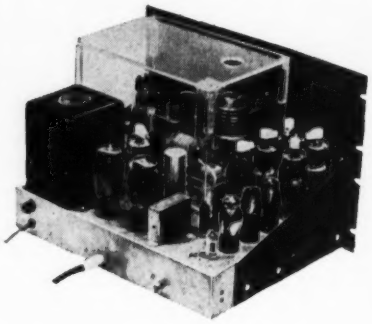
bleeder circuit consists of 1-percent wire-wound precision resistors with a tap near ground end to give a one-volt reading at full-scale; "glassmike" high-voltage filter capacitors; oil-filled low-voltage capacitors; "Sola" regulated low-voltage and filament supply.—*Radiation Instrument Development Laboratory, 2337 W. 67th St., Chicago 36, Ill.*

Mention No. 972 when filling out card.

High-voltage Power Supply

New "Model LAB-30" is continuously-variable 1 to 30 kv. with regulation of 0.5 percent at 1 ma. Up to 2 ma. may be drawn from 20 kv. down. Unit is



made in a rack model as well as a bench model. Also available: "LAB-30PN" reversible-polarity unit having same characteristics as standard model; "LAB-30-2" continuously-variable regulated from 1 to 30 kv. at 2 ma.; "LAB-40" continuously-variable regulated 25 to 40 kv. with 4 to 6 kv. focus tap for use with flying-spot kinescope recording tubes, etc. All units available with slight modifications in electrical characteristics to meet users' specifications.—*Spellman Television Co., Inc. of 3029 Webster Avenue, Bronx, N. Y.*

Mention No. 973 when filling out card.

Ruggedized Electrical Indicating Instruments

New "Series R-210" 2.5-inch and "R-310" 3.5-inch ruggedized instruments meet government spec. MIL-M-10304-SC; are said to incorporate "features heretofore unobtainable in ruggedized instruments." Mechanism is suspended by internal rubber ring mounts. External rubber grommet with interlocking part of front bezel eliminates glass breakage and bezel distortion. Glass-to-metal seal terminals withstand 3000-volt breakdown test under extreme humidity.—*DeJur Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

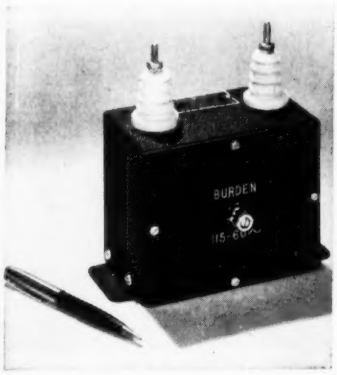
Mention No. 974 when filling out card.

D-c. Voltage-measuring Reactor

New d-c. voltage-measuring reactor provides increased safety by insulating instrument circuit from power source. Present industrial method of measuring d-c. voltages is to bring leads directly from source to instrument panel; hence hazard in measuring circuits of

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

more than 500 volts. New device consists of a saturable-core reactor with a single d-c. winding, two a-c windings, and proper range resistors. D-c. winding has a saturating effect on core, and a-c. windings (supplied from a



separate power source) deliver a rectified average current which is a function of degree of saturation of core. A selenium bridge rectifier in a-c. circuit permits interpretation of average current. A calibrating adjustment permits final adjustment of output current to burden used: design resistance 25 ohms; burden should not exceed 100 ohms. Accuracy 0.5 percent of full-scale.—*General Electric Co., Schenectady 5, N. Y.*

Mention No. 975 when filling out card.

Double-shielded Screen Rooms

New portable radio silence test chambers, originally designed to meet atomic project requirements, feature a double-screen design in which screens are

physically and electrically insulated from each other, are said to afford attenuation qualities substantially superior to those of single-screen design. Standard 31 by 91 in. panels make erection of screen room a matter of a few seconds per panel. Doors placed where needed. Distance between inner and outer screen approx. 1⅝ in. All hardware copper-plated; copper tacks used as needed; plywood floor.—*Dep't P, Lindgren Screen Room, 4515 N. Ravenswood Ave., Chicago 40, Ill.*

Mention No. 976 when filling out card.

Screen-room Access Door

New access door developed for maker's "Cell-Type Shielded Enclosures" (screen rooms) permits easy transfer of materials in and out without opening

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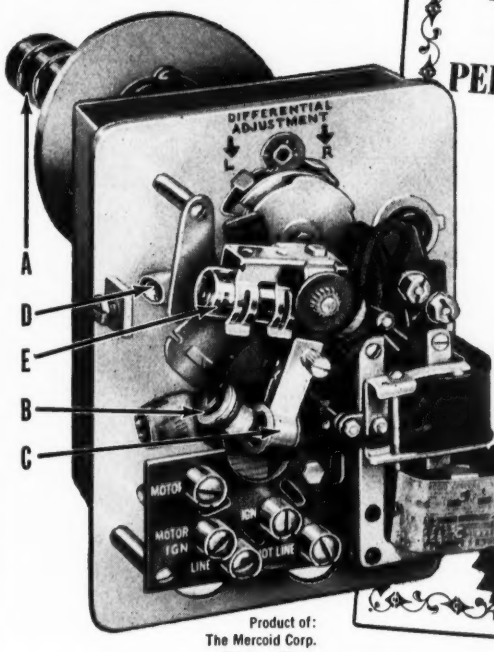

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During normal operation, the rise in stack temperature will actuate bimetal coil "A" in the stack and cause heater coil "B" to move away from bimetal loop "C" and open ignition switch "D" Should ignition fail to occur when the burner is started, heater coil "B" remains within bimetal loop "C" as the stack temperature does not rise. The current flowing through coil "B" heats up the bimetal loop "C" and stops the burner after the predetermined time has elapsed for which the safety has been set. In the event of flame failure, the stack temperature lowers causing the heater coil "B" to move into bimetal loop "C" and after predetermined time, safety switch "E" releases and stops the burner.

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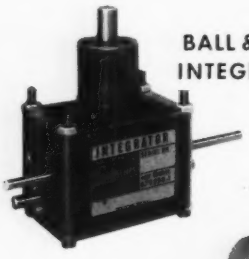
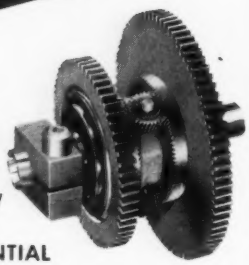


BALL & DISC
INTEGRATOR



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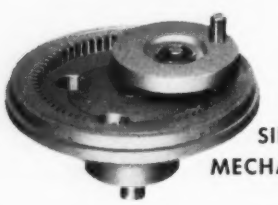

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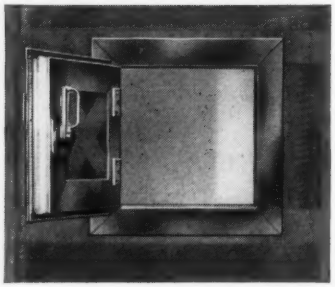

large entrance doors. Two sizes: 16 and 24 in. sq.—*Ace Engineering and Machine Co.*, 3644 *N. Lawrence St., Philadelphia* 40, *Penna.*

Mention No. 977 when filling out card.

Radioactivity Counter

New "Model DU-1 Candid Decade" is a basic ring-of-five-and-binary decade unit. Main feature is its characteristic of disclosing scaling errors. Resolution is two microseconds. Input pulse of (—)

140 volts with a rise time of less than 0.5 microseconds is required; an output pulse of this character from unit provides for cascade operation without buffer amplifiers. Tube complement is six 12AT7's. A (+) 140-volt pulse drives a mechanical six-digit register. Electrical requirements are 6.3v 1.8 amps, and 300v 45 ma.—*Nuclear Measurements Corp., Indianapolis, Indiana.*

Mention No. 978 when filling out card.

Radioactivity Counter

New model of "Autoscaler" has a completely electronic scaling circuit of 12 scales-of-two; is so designed that any predetermined count corresponding

to powers of two from 4 to 4096 may be selected. Panel-mounted neon lights indicate progress of count and elapsed time is shown on odometer-type reg-

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Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

ister which reads to 999.99 minutes with an accuracy of 0.01 minute. Timer stops automatically when predetermined count is completed. End of a counting run is signaled audibly by a 120-cycle tone; and each pulse by a sharp click. Other features: automatic resetting of scales when count stops; coincidence loss of less than 0.8 percent for up to 100,000 random pulses per minute; resolving time of 5 microseconds; stop button to interrupt the count at will.—*Tracerlab, Inc.*, 130 *High Street, Boston* 10, *Mass.*

Mention No. 979 when filling out card.

Radiation Monitor

New "Omniometer," all-purpose instrument for measurement of radiation, may be employed with all types of sensing elements in general use such as

Geiger, proportional, and scintillation counters. Among features: two high-voltage supplies provide overlapping voltage ranges from 500 to 5000 volts. Sensing-element pulses of 0.25 volt or higher are fed directly to scaling circuit; if lower, through amplifier. Scaler has a variable scaling factor of 64, 128, 256, and 512. Counting switch automatically actuates built-in timer which gives time interval necessary to accumulate desired number of counts.—*Radiation Counter Laboratories, Inc.*, 5122 *West Grove St., Skokie, Illinois.*

Mention No. 980 when filling out card.

Gamma-radiation Monitor

New "Radector" utilizes Neher-White Ionization Chamber whereby it is possible, on a single scale, to measure from ordinary background radiation to over 1500 R/hr., i.e. from radiation of common soils to rays over 15,000,000 times as strong. Civil Defense Model (illustrated) measures from 0.02 to 500 R/hr. on a single logarithmic scale; measures 5 x 3 x 3 in.; weighs 2 lbs. Battery life

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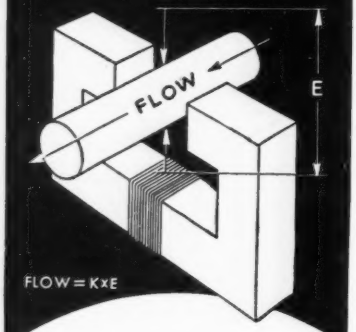

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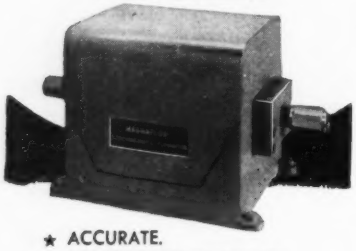

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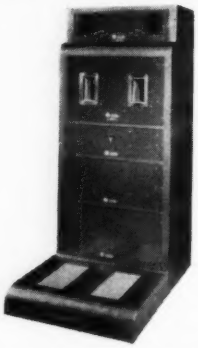
is said to be nearly equal to shelf life. "Accuracy is within plus-or-minus 10 percent of radiation intensity shown anywhere on scale."—*Jordan Electronic Mfg. Co., Inc.*, 9042 *Culver Blvd, Culver City, Calif.*

Mention No. 981 when filling out card.

Hand and Foot Monitor

New "Hand and Foot Counter" for monitoring of beta-gamma contamination on hands and feet of radiolaboratory technicians is completely auto-



matic: user steps onto platform and places his hands in two paper-lined slots. Automatic switches light up a "counter in operation" sign and then indicate whether check is satisfactory or if decontamination is required. If user does not operate unit for correct length of time, another sign lights up advising him to reset and repeat check. —*Nuclear Instrument & Chemical Corp., 229 West Erie St., Chicago 10, Ill.*

Mention No. 982 when filling out card.

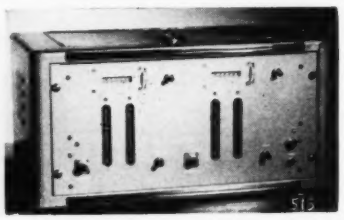
Radioactive Compound

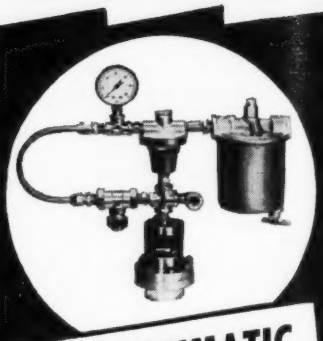
New U. S. Atomic Energy Commission regulations permit certain quantities of radioactivity in specific forms to be released without routine licensing. First available quantity is 40 milligrams of carbon-14-labeled d-glucose (about size of a grain of wheat), offered directly from stock of undersigned. This quantity produces about 2,000,000 disintegrations (or counts) per minute.—*Nuclear Instruments & Chemical Corporation, 229 W. Erie St., Chicago 10, Ill.*

Mention No. 983 when filling out card.

Multichannel Scaler

New "Model 14" multichannel scaler, designed for counting systems that require more than one scaling circuit, is said to be ideal for use with pulse height





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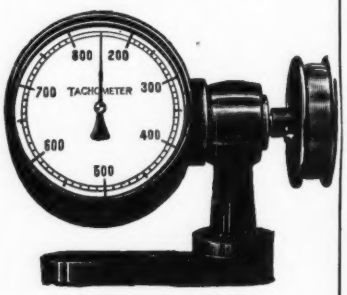

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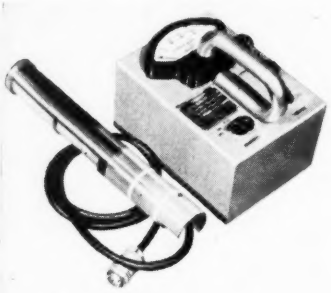
analyzers or coincidence counting systems. With modifications to meet individual needs, unit provides a custom-made instrument. It is available with 2, 4, or 4 channels on one chassis, each channel consisting of a scale of 10, 100, or 1000 and a mechanical register. Count and reset operation for each channel may be controlled individually, or by a master control, remotely by a plug-in arrangement on rear of chassis. —*Radiation Instrument Development Laboratory,* 2337 *W. 67th St., Chicago 36, Ill.*

Mention No. 984 when filling out card.

Beta-gamma Probe

New "Raychronix Model D-5A," beta-gamma probe, for use with "Samson Alpha Survey Meter," contains a freon-filled ionization chamber and an elec-

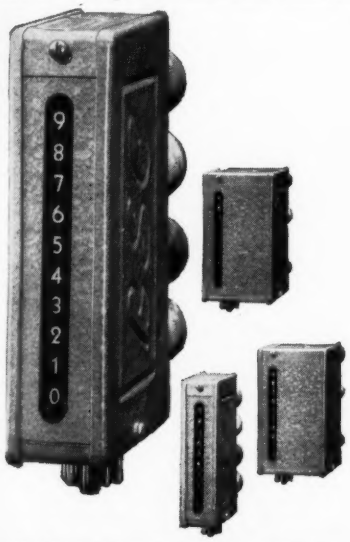


trometer preamplifier. A rotating 1000 mg/cm² stainless-steel shield provides for beta discrimination. Probe extends original Samson ranges to 0-0.25, 1.25, 6.25, 25, 125 and 625 mr/hr.—*Radioactive Products, Inc.,* 443 *West Congress St., Detroit* 26, *Mich.*

Mention No. 985 when filling out card.

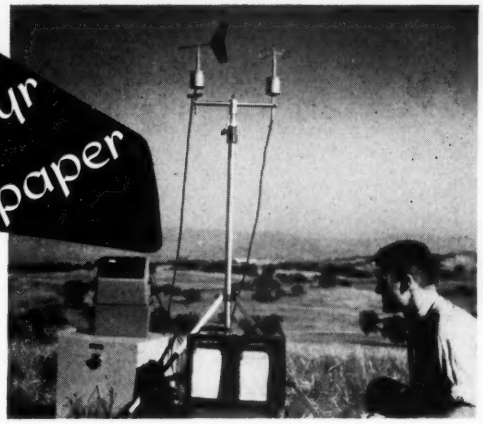
Decimal Counting Units

New Decimal Counting Units are direct-reading electronic counters capable of operating at speeds up to 1,000,000 counts per second and resolving



paired pulses separated by as little as 0.8 microseconds. Each counter is a plug-in unit; counts from 0 to 9 and displays an illuminated digit; tenth

how to put a zephyr on paper



Those light winds, so critical in air-pollution and microclimatological studies, resist precise recording by conventional meteorological methods. The new Beckman & Whitley electronic wind-speed and -direction recorder has been developed specifically to document air movements in the range from 30 down to a fraction of one mph. Portable battery-operated model, as illustrated, or multiple-location type for telemetering to a central monitoring station. Send for details.

Beckman & Whitley INC., SAN CARLOS 1 CALIFORNIA

meteorological equipment • explosive-actuated mechanisms

MICROSYNS

Position Indicator Type 1C-001A

The Doelcam Microsyn is an electro-magnetic four pole, reluctance bridge unit providing rugged construction, inherent electrical and mechanical simplicity, and high accuracy performance in the following applications:

Position Indicator provides an electrical indication of angular displacement with high signal-to-noise ratio.

Stiffness Motor operates as a torsional spring with adjustable stiffness coefficient.

Torque Generator supplies a torque proportional to excitation and independent of shaft rotation.

Variable Inductor offers an inductance that varies linearly with shaft rotation.

The Doelcam Microsyn can be designed for special applications in a wide variety of sizes. Units are available in instrument housings or as rotor and stator combinations to provide for individual mounting.

For more details, write to:

DOELCAM CORPORATION

56 Elmwood Street, Newton 58, Massachusetts.

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PRECISION TEN-TURN POTENTIOMETER

1. You get permanent accuracy because the resistance wire is locked in place. It is precision positioned and moulded integrally with the housing.
2. You get permanently accurate settings, smooth action and low uniform torque provided by the stainless steel, precision ground, double thread lead screw guiding the moving contact.
3. You get precise positioning of the moving contact because of the two bearings supporting the rotor assembly.
4. You get good rigid terminals because they are moulded integrally with the housing.
5. Terminals soldered to ends of resistance element before moulding. Entire resistance circuit is an integral part of the housing.
6. You get accurate setting and resetting due to anti-backlash spring in contact guide.
7. You get a fine resolution because of the 43½" length of resistance wire in the spiral element.
8. You get a resistance output directly proportional to shaft rotation within ±0.1% of the total resistance. Every potentiometer is automatically machine tested for linearity at 101 points.

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Units for immediate shipment:
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Special resistance values made to order.

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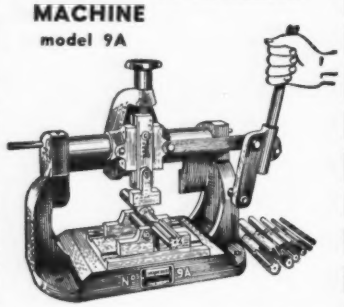

This widely adaptable hand machine also comes in air and motor driven models. It's for marking tools and parts of steel, all metals and plastics. It marks rounds with a flat die—flats with a round die. Write now for fully descriptive illustrated literature and prices.

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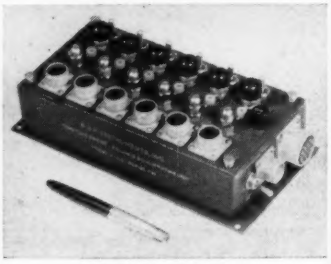
Oscillograph Installations CAN be compact and simple.

Miniature Bridge-Balance & Calibrating Unit



Model 6-100 Series

Designed in the field to satisfy the requirements of FLEXIBILITY, SIZE, & SIMPLICITY so important in testing.
Matches any resistance-type or strain gage pickup to any oscillograph galvanometer for the DIRECT RECORDING of STRAINS, LOADS, ACCELERATIONS, FORCES, etc.
Independent adjustment for each channel of:
Voltage ★ Balance ★ Calibrating Level & Phase ★ Galvanometer Damping.
Accessible Resistor Rack accommodates calibrating and series or shunt damping resistors.

Write for bulletin.

B and F Instruments, Inc.
1115-15th St., N.W., Washington 5, D.C.

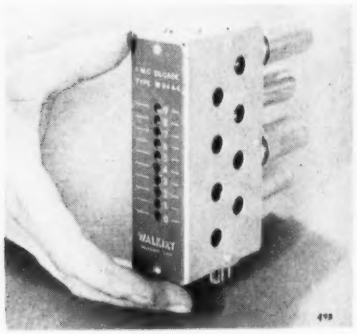
NEW INSTRUMENTS

pulse resets to 0 and generates one pulse, which may be applied to input of a following counter or other device. Reset to 0 by momentarily opening grid return circuit. DCU's may be connected in cascade for any desired number of decimal places.—*Berkeley Scientific Corp., 2200 Wright Ave., Richmond, Calif.*

Mention No. 986 when filling out card.

One-megacycle Decade

New "Type M2444" scale-of-ten scaler operating to over one million operations per second, with minimum power consumption, utilizes only four dual

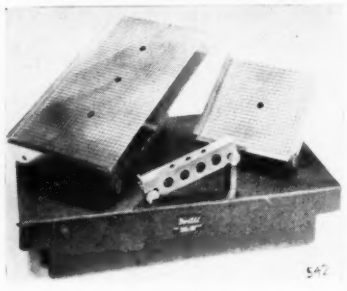


triode tubes. External reset is possible through application of a negative pulse, either automatically or manually. Unit has ten illuminated positions for direct decimal count indication. Successive decades can be cascaded giving a unlimited counting capacity without count indication.—*The Walkirt Co., 145 West Hazel St., Inglewood, Calif.*

Mention No. 987 when filling out card.

Sine Plates

New sine plates afford larger working surfaces, for precision checking of angles on large work pieces, than previously available. Five-inch plate has top area 6 x 6 in.; ten-inch plate 7 x 12



in. Feature is "three-point" base arrangement: two short cylinders, 5.25 in. apart between centers, are used in place of usual single-piece cylinder. This arrangement minimizes errors. Over-all accuracy is held within tolerances designed by NBS and proposed MIL-S-4458 (USAF) for sine bars and plates of laboratory grade.—*The DoALL Co., Des Plaines, Illinois.*

Mention No. 988 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

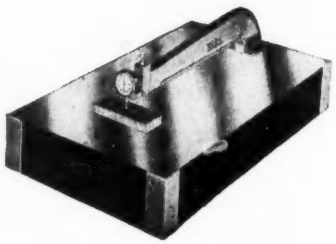
Dial Indicator

New "Universal Dial Test Indicator" features one-piece construction of base and shank, resulting in an assembly that will not be loosened under severe use and on which mechanism is mounted; hence alignment of moving parts independently of case. Simplified mechanism has no gear train. Jeweled thrust bearing enhances smoothness of operation. Improved hole attachment screws directly into base.—*Lufkin Rule Co., Saginaw, Mich.*

Mention No. 989 when filling out card.

Indicating Micrometer

New "Ti-Pi Floating Caliper Gage" comprises a dial indicator and means for quickly lifting it and then gently lowering it (to an exact height above a reference point) in order to measure an object. Accessories (not shown) include a setting bar and various contact points. Among advantages are: (1) speed; (2) ability to gage soft materials.—*Ti-Pi Co., 1000 Broadway, Kansas City 6, Missouri.*



Mention No. 990 when filling out card.

Tachometer Heads

New "Series 56M" heavy-duty tachometer heads, for use with maker's tachometer indicators, recorders, or controls, are suitable for measuring speeds of cement kilns, ball mills, metal working machines, etc., between 200 and

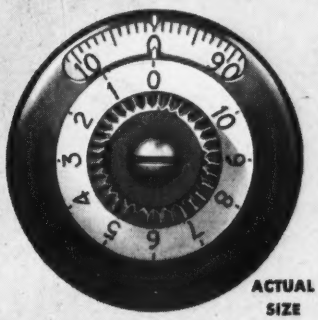
MICRODIAL
TEN TURN-COUNTING DIAL

Microdial is composed of two concentrically mounted dials . . . one for counting increments of each turn and the other for counting turns. The incremental dial has 100 equal divisions and is attached rigidly to the shaft so there is no backlash. Thus the contact position is indicated to an indexed accuracy of 1 part in 1000. Rotation is continuous in either direction. There are no stops on the Microdial assembly.

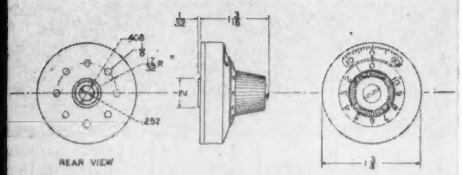
COMPACT . . . Microdial has same O.D. as Micropot . . . requires no more panel space.

CLEAR READING . . . Forced fast-reading tests showed only 1/20th as many errors with Microdial open window as with next most legible dial. Turn counter distinguishes between 0 and 10 turn readings, and accelerates to avoid confusion on readings near integral turns. Precise readings are made from larger dial with maximum separation of graduations and wide angle visibility.

CONVENIENT . . . delivered completely assembled with dials synchronized. Easily mounted in a few seconds. All dials may be locked.



ACTUAL SIZE



REAR VIEW

Microdial . . . turn-counting dial, primarily designed for use on Micropot ten turn linear potentiometers . . . use it on any multiturn device having ten turns or less.

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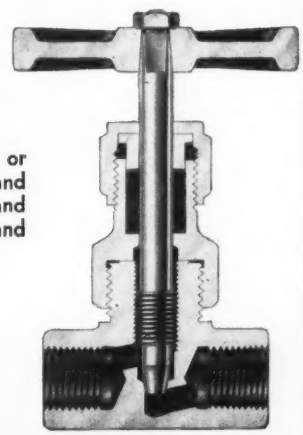

DRAGON NO. 40 VALVES

are recommended for control of gases or other fluids which do not attack aluminum and are particularly suitable for use in sour gas and sour crude areas in both the production and refining of oil and gases.

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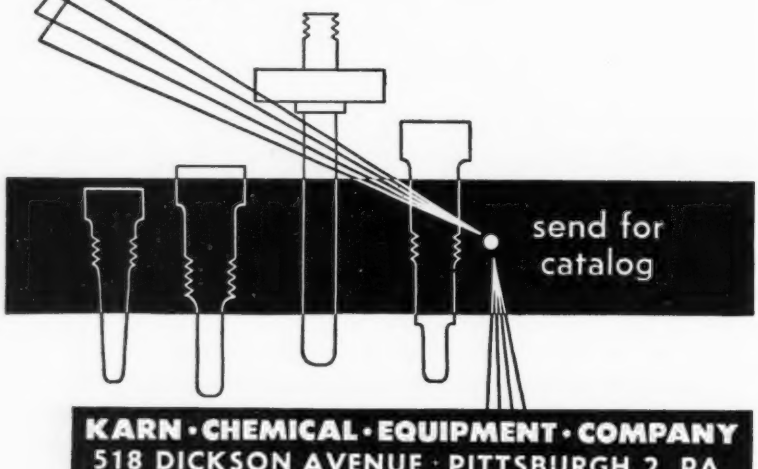
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

KARN
THERMOWELLS



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A. M. Units are packed dry and activated with water . . . once activated they may be efficiently discharged at temperatures as low as −60°F. and as high as + 150°F.! Write Dept. IM for full information on standard and special types.

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NIAGARA METERS

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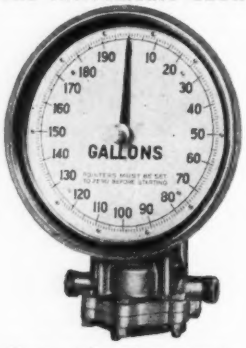
The Instruments Show



Single nutating piston volumetric displacement type, with integrating registers.

For most liquids including:

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- SOLVENTS
- CHEMICALS
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2906 Main St., Buffalo, N. Y.

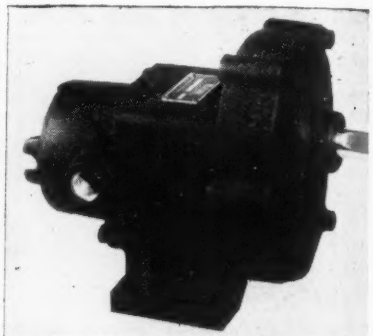
NEW INSTRUMENTS

10,000 rpm.; can be overspeeded 2 to 10 times without damage.—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*

Mention No. 991 when filling out card.

Tachometer Heads

New "Series 57M" heavy-duty tachometer heads for measuring speeds as low as a fraction of an rpm. are for use with maker's tachometer indicators, recorders, or controllers. Speeds up to

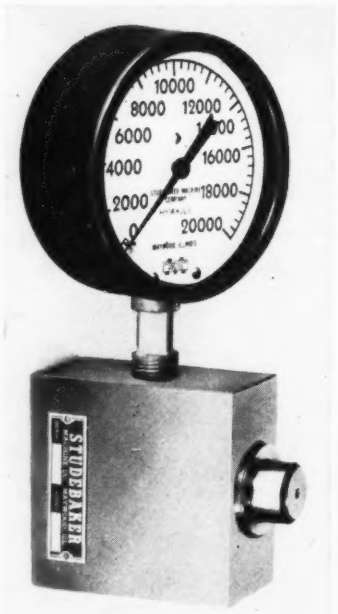


199 rpm. for full-scale indication can be measured. Overspeeding of 2 to 10 times rated values results in no damage. —*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*

Mention No. 992 when filling out card.

Ram-force Indicator

New "Pressure Tester" indicates actual force in pounds of ram on work



in presses; comes in three sizes: 10,000 lbs., 50,000 lbs., 100,000 lbs.—*Studebaker Machine Co., 1126 S. 9th Avenue, Maywood, Ill.*

Mention No. 993 when filling out card.

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

Anti-static Compound

New "Photo-Sweep No. 1341" eliminates static electricity problem in delicate instrumentation. When applied to glass and plastic surfaces, it renders them anti-static by depositing an invisible coating of chemicals that bleed off static electricity into the air. Available in 6-ounce aerosol "bombs"; also in quarts and gallons.—*Electro-Chemical Products Corp., 60 Franklin Street, East Orange, N. J.*

Mention No. 994 when filling out card.

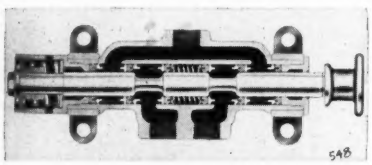
Manual Valve for Instrument Control Service

New manual reset valve with air cylinder release may be designed to close or open upon loss of air or application of air to pilot cylinder. Action of air trips mechanical latch causing valve to operate. Valve must be manually reset; can be provided with auxiliary switches for indicating lights, electric control circuits, etc. Available types: Two-way N-O or N-C, 250 psi., 600 F., 0.125 to 3 in.; Three-way N-O or N-C, 600 psi., 600 F., 0.125 to 0.5 in.; Four-way N-O or N-C, 250 psi., 600 F., 0.25 to 1.5 in.—*Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.*

Mention No. 995 when filling out card.

Control Valve for Cylinders

New spring-centered neutral valve is said to be good for "over twenty million cycles of maintenance-free operation," is available in sizes from 0.25-in. to 1-in.; in knob, lever, foot, clevis,

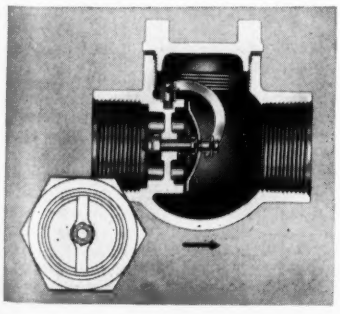


double-acting cylinder and d-a. cyl. with solenoid pilot-valve styles; in 3-way and 4-way piped exhaust types; for controlling air, water, oil or inert gases; for pressures to 300 psi. Specific function is to stop and hold single- or double-acting cylinders in any position.—*Valvair Corp., 962 Beardsley Ave., Akron 11, Ohio.*

Mention No. 996 when filling out card.

Gas-line Check Valve

New "Callahan" horizontal non-sticking disk-type back-pressure check valve for gas lines permits unrestricted gas flow at negligible pressure drop



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automatic slideback

peak pulse—low duty cycle

VOLTMETER

Far more versatile than conventional types, the C.G.S. peak pulse voltmeter reads *rapidly* and *accurately* on pulse widths of .25 microseconds and at repetition rates of 10 pps. The instrument reads on either positive or negative pulses. Controls include an on-off, range selector and input polarity switch; zero set control. A switch which throws a D.C. restorer into the circuit provides accurate peak to peak measurements of sine and square waves.

SPECIAL FEATURES—

- Wide Voltage Range — 5 scales from 10 to 5000 volts full scale.
- Pulse Width 0.25 microseconds to 50 milliseconds.
- Accuracy ±3% of full scale.
- Input Impedance 200,000 ohms.

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S.S.White MOLDED RESISTORS

The All-Weather Resistors

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The resistors that give you . . .

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STANDARD RANGE
1,000 OHMS TO 9 MEGOHMS

These resistors are used extensively in commercial equipment, including radio, telephone, telegraph, sound pictures, television, etc. They are also used in a variety of U.S. Navy equipment.

HIGH VALUE RANGE
10 TO 10,000,000 MEGOHMS

This unusual range of high value resistors has been developed to meet the needs of scientific and industrial control, measuring and laboratory devices — and of high voltage applications.

SEND FOR BULLETIN 4906

It gives details of Standard and High Value Resistors, including construction, characteristics, dimensions, etc. Also described are S.S. White 80X Resistors, designed for extremely high voltage equipment. Copy with Price List sent on request.

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Pneumatic Weight Transmitters

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A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

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Special Tools and Products

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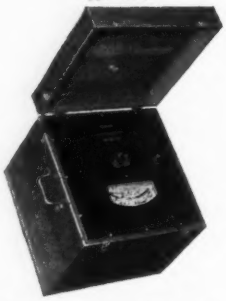
RAWSON ELECTROSTATIC VOLTMETERS

Type 518



Available ranges 100 volts to 35,000 volts

Measure true R.M.S. values on A.C., no waveform or frequency errors.

NO POWER CONSUMPTION
Leakage resistance greater than one million megohms. These meters may be used to measure **STATIC ELECTRICITY!**

Ideal for measuring high voltage power supplies with zero current drain. Rugged, well-damped movement. All elements surrounded by metal shielding for accuracy and safety.

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RAWSON ELECTRICAL INSTRUMENT COMPANY
112 Potter St. Cambridge, Mass.

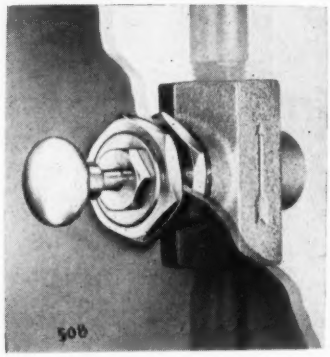
NEW INSTRUMENTS

with lightweight disk in full open position at pressures as low as 1 in. water column. If air back-pressure should exist on pre-mixed air and gas systems, valve closes and prevents air from entering low-pressure gas distributing lines.—*Henry Flow Control Co., Melrose Park, Illinois.*

Mention No. 997 when filling out card.

Non-leaking Push Valve

New "Self-Closing Push Valve," for use in gas and air lines where manual control of an intermittent flow is required and where there must be no leak-



age through valve or around valve stem, is opened by pressing a knob and closes automatically when knob is released. Two styles: "Model PV" (illustrated), for panel mounting; "Model LV" for in-line mounting; both for 0.25-in. pipe size.—*King Engineering Corp., Box 520, Ann Arbor, Mich.*

Mention No. 998 when filling out card.

Plug-in Subassembly

New replaceable subassembly, suitable for subminiaturizing vacuum-tube circuits such as multivibrators, analog computing amplifiers, counting chains,

etc., is suitable for operation under conditions of vibration, temperature, and humidity found in jet planes: complies with Specs. AN-E-19 and MIL-T-5422. Eight to twelve sub-min tubes plug into a high-thermal-conductivity magazine atop a component space filled with thermosetting compound after assembly. An over-all removable shield cannister makes good thermal contact, allowing a total of 15 watts to be dissipated in assembly. Standard 11-pin base or mul-

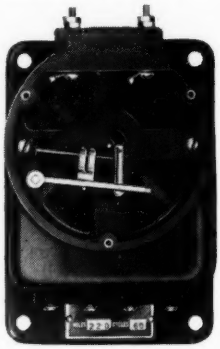
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

ti-pin connector; also a fastener for mechanically securing assembly to its socket.—*Avion Instrument Corp.*, 299 *State Highway* 17, *Paramus, N. J.*

Mention No. 999 when filling out card.

Phase Sequence Relay

New phase sequence relay offers positive phase protection to all types of polyphase rotating machinery, which might function improperly or be dam-

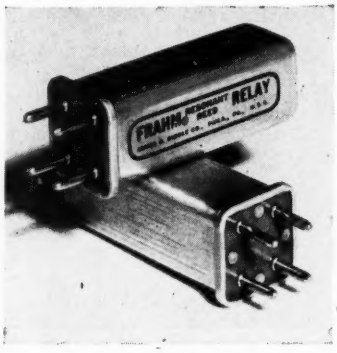


aged by the application of reverse phase sequence, extremely low voltage, or single phase voltage. Power consumption 5 watts per phase. Relay will operate on either 2- or 3-phase a.c.; is made for all voltages and frequencies ordinarily encountered.—*The Shepard Elevator Co.*, 5000 *Brotherton Road, Cincinnati* 9, *Ohio.*

Mention No. 1000 when filling out card.

Resonant-reed Relays

New resonant-reed frequency-sensitive relays are a new type of electromechanical device, responding to alternating signals within specified fre-



quencies and amplitudes. They simplify transmission of a number of control signals over a single circuit: not only wire circuits but radio and carrier systems. Since each Reed Relay will only respond to a narrow band, a number of relays may be operated simultaneously by an equal number of source generators with non-overlapping frequency bands. In range 200-500 cycles, up to 16 channels can be operated with no interference between channels.—*James G. Biddle Co.*, 1316 *Arch St., Philadelphia* 7, *Pa.*

Mention No. 1001 when filling out card.

Protective Relay

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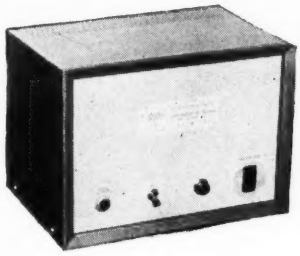

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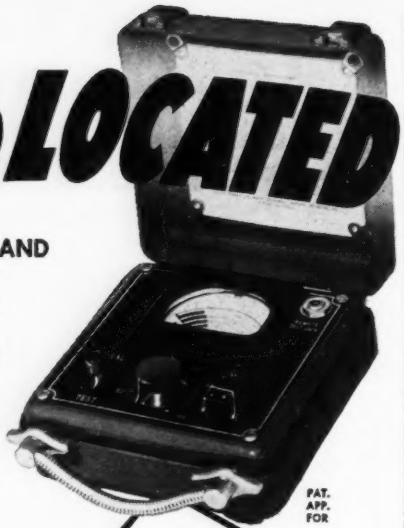

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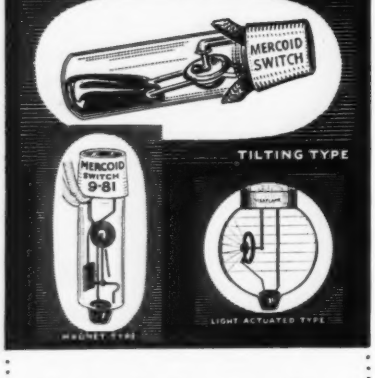

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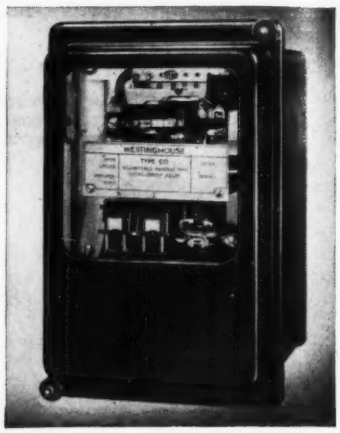
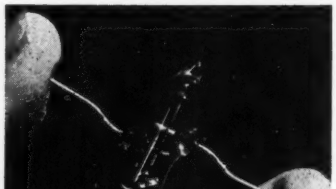


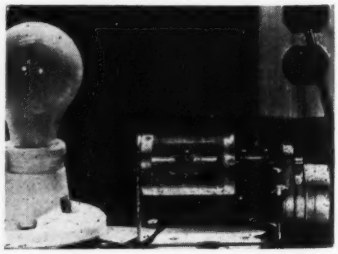
protection of transmission and distribution lines. Units are available in three ranges: 0.5 to 2.5, 2 to 6, or 4 to 12 amps. Accurate timing is provided by adjustable magnetic plugs in newly-designed "E" element electromagnet. Accurate pick-up at tap value of current for all disk positions is provided by two independent adjustments. Accurate adjustment of damping torque of permanent magnet can be made by means of a keeper screw without moving magnet. —*Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Penna.*

Mention No. 1002 when filling out card.

Pulse-type Mercury Switch

New "Pulse Switch" is of new design said to make posible new applications beyond possibilities of older types of mercury switches. A glass tube contains a drop of mercury (or, for operation below minus 40 F., a mercury-thallium amalgam). It can be rotated around axis of its two lead wires. Then mercury globule rolls past electrodes, momentarily short-circuiting them. This powerful pulse (as much as 1 kw.) may flash signals for aircraft beacons or railroad crossings, actuate vending machines and other equipment where mul-





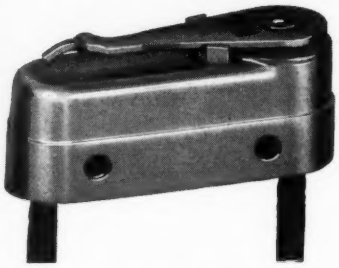
Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

tiple contacting or chatter that would cause repetition must be avoided. Switch rotates with almost negligible power, so that even a watt-hour meter rotor can rotate it.—*Saxl Instrument Co., Harvard, Mass.*

Mention No. 1003 when filling out card.

Waterproof Switch

New "Type 4HS" snap-action switch incorporates potted waterproof terminal leads and a hermetically-sealed contact

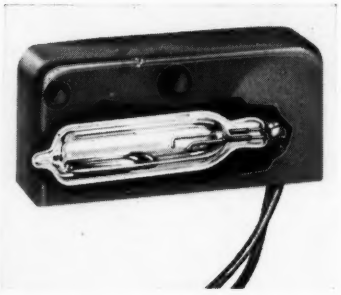


chamber.—*Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Illinois.*

Mention No. 1004 when filling out card.

Mercury Switches

New mercury switches are embedded in plastic "potting" compounds for added protection against shock; also offer additional mounting means. First

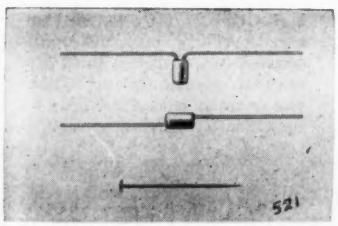


of new switch assemblies is "IMPI" switch, 2.5 inches long, which provides less than 1 degree differential angle. Rating: 2 amps. 115 vac. or 1 amp. 115 vdc. Contact arrangement: s-p., n-o.—*Micro Switch, Freeport, Illinois.*

Mention No. 1005 when filling out card.

Subminiature Selenium Diodes

New subminiature selenium diodes are designed for stable operation in an ambient temperature range of −60 to +100 C.; are provided with pigtail leads to facilitate wiring into crowded



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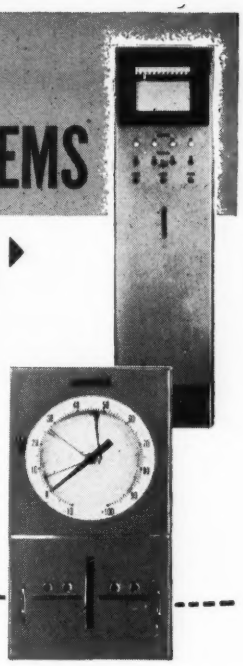

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.018 x 1.5	35,000 ohms	82,290 ohms	229,600 ohms

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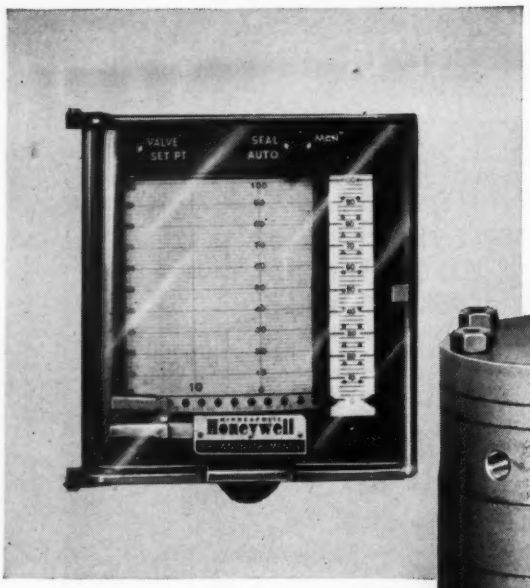
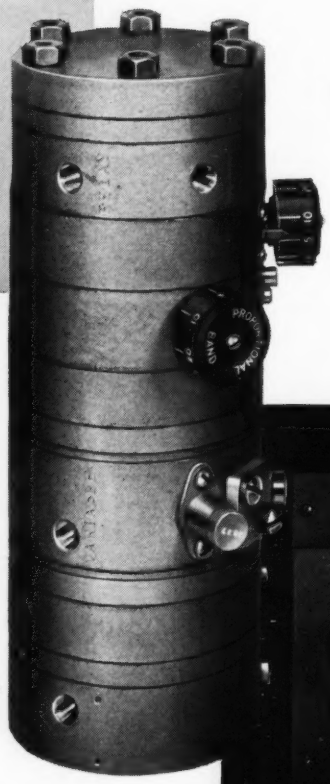


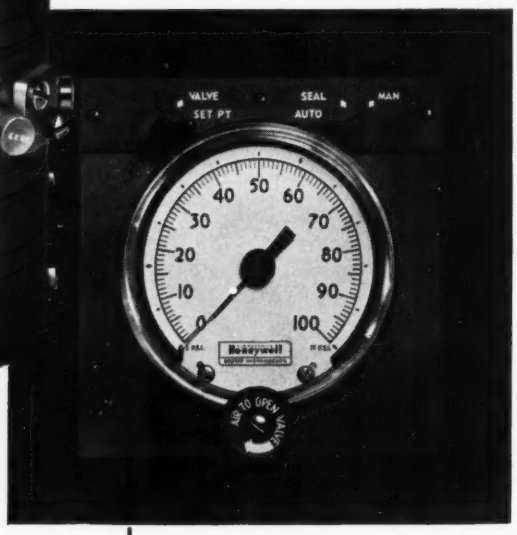
TEL-O-SET RECORDER

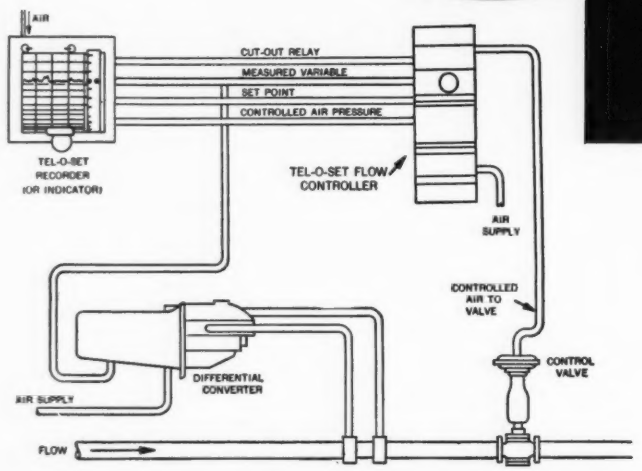
Features withdrawal of chassis for full 8-hour chart visibility without interrupting operations, bumpless shifting from automatic to manual operation, all adjustments from front of panel, built-in adjustable restrictions for pulsating flow . . . requires panel space just 5 1/16" high by 5" wide. Write for Specification Sheet No. 769.



TEL-O-SET CONTROLLER

Available in adjustable and fixed proportional band models, and with three control forms . . . for flow, temperature, pressure, level and other process variables. Universal bracket permits optimum flexibility in mounting . . . coded, interchangeable sections and split manifold contribute to simplified maintenance. Write for Specification Sheet No. 768.





TYPICAL ENGINEERED *TEL-O-SET* CONTROL SYSTEM — Pictured in this diagram are the elements of the *Tel-O-Set* Family, designed and built as an integrated loop. Here the system is applied to the control of flow with the *Differential Converter* used as transmitter.

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Can be used with any pneumatic transmitter, having a 3-15 psi controlled air output, regardless of the primary element being used. Provides indication of process variable, set-point of controller or controlled air pressure to valve when on automatic control . . . is easily shifted to manual operation. Panel cut-out size same as recorder. Write for Specification Sheet No. 770.

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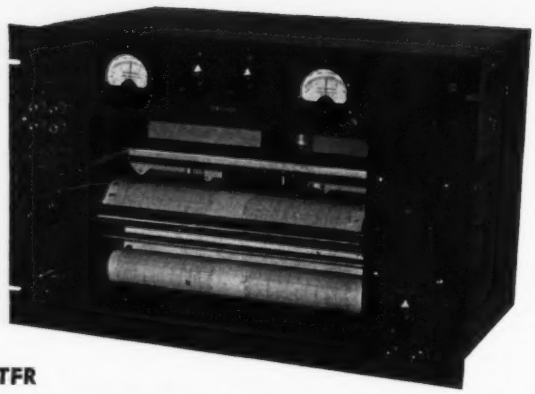

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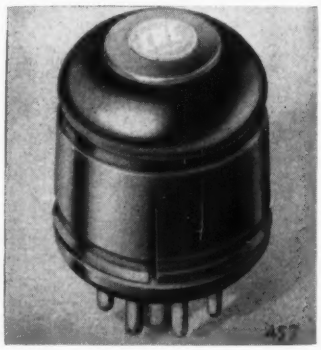
Mention No. 1006 when filling out card.

Ferro-resonant Flip-flop

New "Model MC" 100-kc. ferro-resonant flip-flop (highly-efficient replacement for vacuum tube in certain counting, amplifying and control applications) has durability, power economy, and low heat dissipation of saturable reactor, yet is small, simple, and



relatively inexpensive. It operates on approx. 10 percent of power needed by a vacuum tube; delivers more than 90 percent of input power as usable output; will not wear or burn out; can be mounted in any circuit; is immune to high acceleration and shock. Units are presently available in octal plug-in base.—*Computer Research Corp., 3348 El Segundo Blvd., Hawthorne, Calif.*

Mention No. 1007 when filling out card.

High-reliability Tubes

New "high reliability" receiving tubes, said to have reduced tube failures by as much as 10 to 1 in certain applications, are now available to replacement tube market under "Five Star" trade name for installation in industrial and communications equipment. They are built to withstand electrical and physical conditions not normally encountered by standard receiving tubes in radio and TV receivers.—*General Electric Co., Electronics Park, Syracuse, N. Y.*

Mention No. 1008 when filling out card.

Gas Thyratron

New "6012" gas thyratron is designed especially for motor-control and low-power inverter service in 60-cps. circuits. Conservatively rated to withstand max. peak inverse anode voltage of 1300 v., max. peak cathode current of 5 amps. and max. average cathode current of 0.5 amps. Negative-control characteristic is essentially independent of ambient temperature over range

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

LIQUID LEVEL

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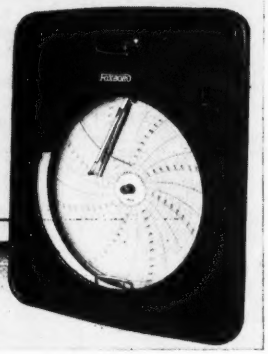
Recorders
Controllers



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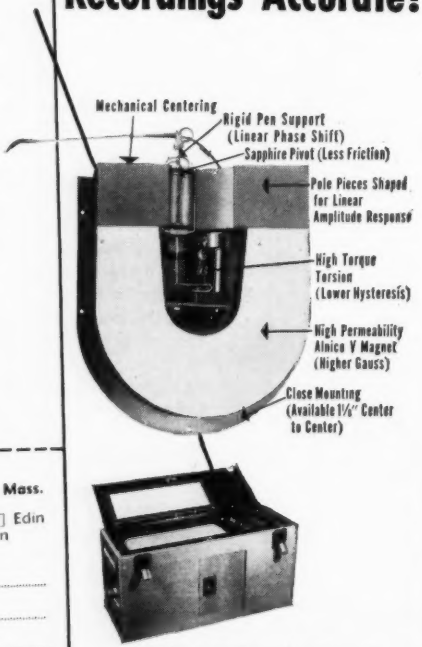
Mechanical Centering
Rigid Pen Support (Linear Phase Shift)
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City..... State.....
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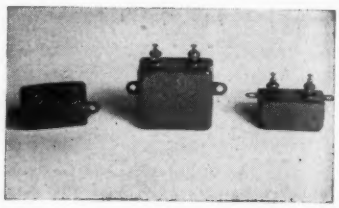
NEW INSTRUMENTS

from −75 to +90 C. Max. over-all length 4.25 in., max. diam. 1.75 in.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

Mention No. 1009 when filling out card.

High-precision Capacitors

New "Stabelex D" capacitors will hold their charge for 200 days or longer; make possible improved computing devices; possess characteristics of ca-



pacitors heretofore available only as standards for laboratory use.—*Industrial Condenser Corp., 3243 North California Avenue, Chicago 18, Ill.*

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Double Rheostats

New double rheostats, in 1120-, 1560-, and 2000-watt capacities, are added to maker's line. Two tubes of same length are mounted between mounting brack-

ets; one slider moves a double contact arm with double copper-graphite contact brushes. Advantage: two ranges connecting both tubes in series or in parallel.—*Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L.I., N. Y.*

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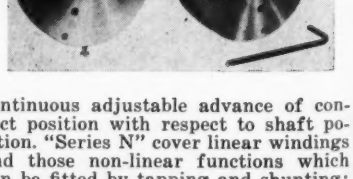
Potentiometer Rheostats

New precision potentiometer rheostats of miniaturized computing type are available as single units or ganged assemblies. A cam-corrector provides



continuous adjustable advance of contact position with respect to shaft position. "Series N" cover linear windings and those non-linear functions which can be fitted by tapping and shunting; "Series C" incorporates a cam-corrector which makes possible accurate fitting of an additional class of more difficult

Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

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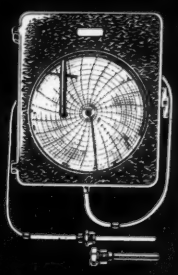

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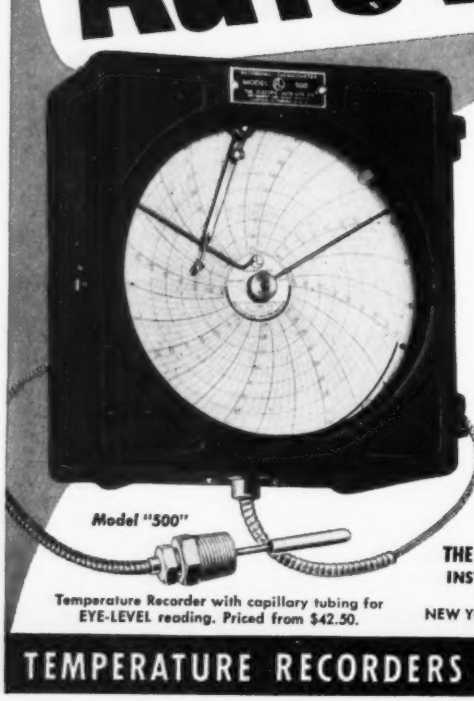

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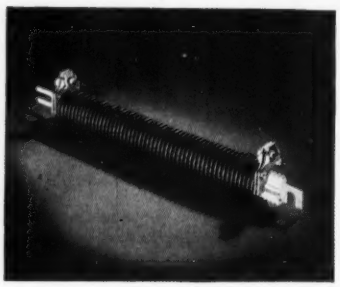
NEW INSTRUMENTS

functions. Accuracy for linear functions is 0.1 percent; for non-linear, 0.25 percent. Closer tolerances can be provided.—*Avion Instrument Co., 299 State Highway 17, Paramus, N. J.*

Mention No. 1012 when filling out card.

High-current Resistors

New "Powr-Rib," edgewound-type resistor, designed for high-current duty in both intermittent and continuous applications, offers high heat dissipation, resistance to oxidation, and ability to withstand shock and vibration without breaking or shorting. — *Ohmite Mfg. Co., 4823 Flournoy St., Chicago, Ill.*



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Deposited-carbon Resistors

New line of "Dalohm" deposited-carbon resistors (non-wire wound) come in three resistance ranges (50 ohms to 5 megohms, 50 ohms to 10 megohms and 100 ohms to 50 megohms). Temperature coefficients 0.014 to 0.050 percent per C. degree; voltage coefficient less than 0.002 percent per volt (average about 0.0012 percent); standard tolerance 1 percent (2 and 5 percent tolerances available). Special coatings for extremely humid conditions.—*Dale Products, Inc., Columbus, Nebraska.*

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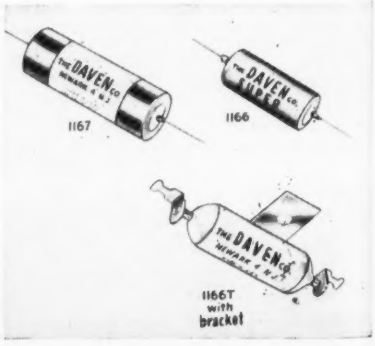
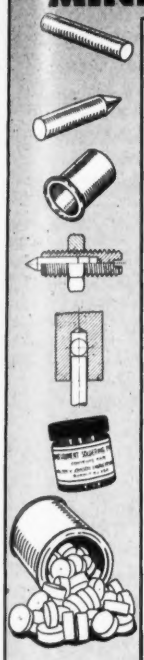
Subminiature Resistors

New hermetically-sealed precision subminiature wire-wound resistors, "Series 1166 and 1167," suitable for many military applications, will withstand salt water immersion, humidity and temperature cycling, and vibration and shock testing. Temperature



Makers of these and other types of instruments are listed in THE INSTRUMENTS INDEX

MINIATURE PARTS



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Micro-smooth instrument pivots.

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In diameters up to ⅜" cut and formed in a variety of materials. Burr free cutting.

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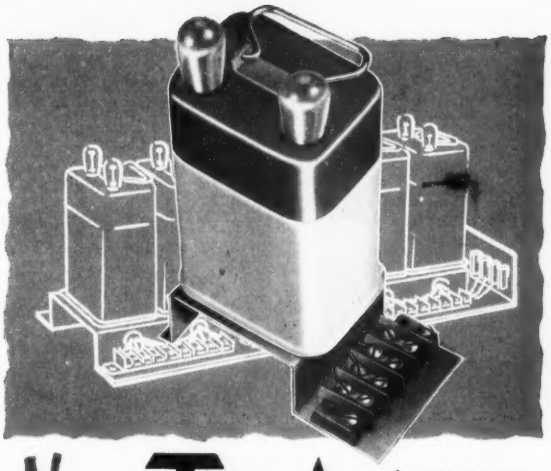

New TEL-ALARM "Unitized" ANNUNCIATOR SYSTEM

- WIDE VARIETY OF CIRCUIT ARRANGEMENTS TO MEET ANY NEED
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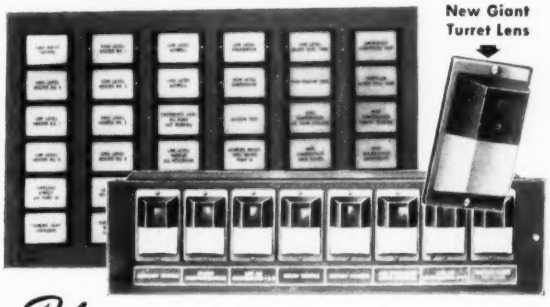

Here is the first completely "unitized" annunciator. Tel-Alarm incorporates a basic relay unit which can be wired into many different circuit arrangements, simply and easily, because of a unique switchboard circuit-header. This makes Tel-Alarm completely standardized for low cost and easy maintenance.

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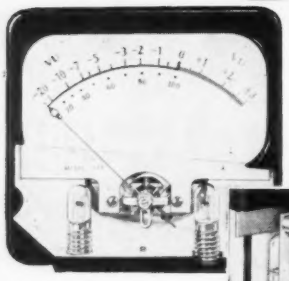

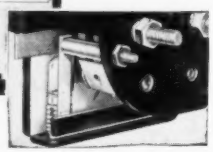

Cutaway views showing positions and connections of lamp assembly.

Available in all ranges 3½" and 4¼" rectangular semi-flush models.

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NEW INSTRUMENTS

coefficients as low as 20 parts per million per degree C. Tolerances as close as 0.1 percent can be supplied; all resistance values obtainable.—*Daven Co.*, 191 *Central Avenue, Newark* 4, *N. J.*

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Tip Jack

New "No. 1899" high-voltage tip jack is designed for stability in electronic test equipment. Nylon insulation withstands 10,000 volts, has negligible moisture absorption. Spring contact is one-piece phosphor-bronze, takes all standard phone tips and test prods.—*Insuline Corp. of America*, 3602 35*th Ave., Long Island City* 1, *N. Y.*

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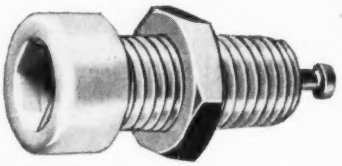
New line of Nylon-insulated tip jacks have breakdown rating of 11,000 volts; nominal capacitance to ⅛ in. panel is 2.0 mmf. Silver-plated phosphor bronze



or beryllium contacts. Minimum withdrawal force, one pound. Nylon bodies available in eleven bright colors.—*E. F. Johnson Co., Waseca, Minn.*

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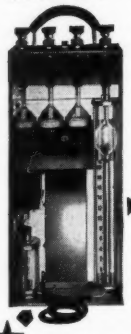
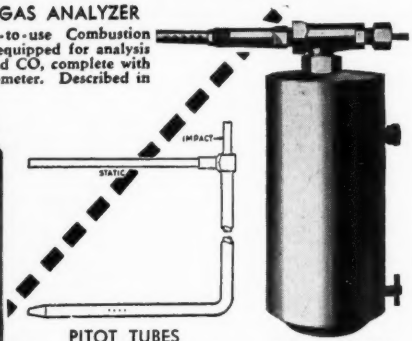
Accurate, easy-to-use Combustion Testing Set is equipped for analysis of CO_2, O_2 and CO, complete with flue gas thermometer. Described in Bulletin 120.



PORTABLE GAS ANALYZER



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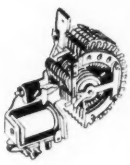

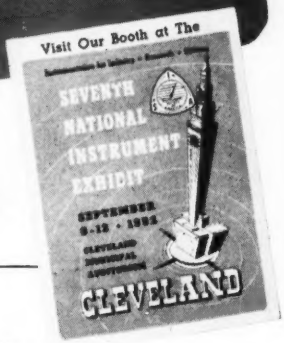

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INSTRUMENT EVENTS
Calendar

Sept. 4-13
International Society of Photogrammetry, Shoreham Hotel, Washington, D. C. For information write L. Ray Smart, U. S. Geological Survey, Trimetrogon Section, Washington 25, D. C.

Sept. 8-12
Instrument Society of America.
Seventh National Instrument Conference and Exhibit.
Public Auditorium, Cleveland, Ohio.

Sept. 8-19
Special course in Aerodynamic Measurements to be held at the MIT Gas Turbine Lab. For information write Dr. Ernest H. Huntress, Dir. of Summer Session, Room 3-107, Massachusetts Institute of Technology, Cambridge 39, Mass.

Sept. 22-30
Third Instruments and Measurements Conference and Exhibition, Stockholm, Sweden. For information write Mr. Yngve Axner, Kungl. Tekniska Hogspolan, Stockholm 70.

Sept. 29-Oct. 1
Eighth National Electronics Conference and Exhibition.
Sherman Hotel, Chicago.
For information write Karl Kramer, Ex. Sec., 852 E. 83rd St., Chicago 19.

Oct. 15-16
Scientific Apparatus Makers Association.
Midyear Meeting of Recorder-Controller Section.
Seaview Country Club, Absecon, N. J.

Nov. 5-8
Scientific Apparatus Makers Association.
Midyear Meeting of Industrial Instrument, Laboratory Apparatus, Laboratory Equipment, Optical, Aeronautical, and Military Instruments Sections. The Homestead, Hot Springs, Va.

Nov. 6-7
Tenth Annual Pittsburgh Diffraction Conference, Mellon Institute of Industrial Research, Pittsburgh, Pa. For information write E. E. Wicker, c/o U. S. Steel Co., 234 Atwood St., Pittsburgh 13, Penna.

Nov. 17-18
AIEE Technical Conference on Electrically-operated Recording and Controlling Instruments. Benjamin Franklin Hotel, Philadelphia, Pa. For information write G. L. Broomell, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44.

Nov. 20-21
Seventh Midwest Conference, American Society for Quality Control, Claypool Hotel, Indianapolis, Ind. For information write Dale A. Cue, Vice-chairman, 7th Mid-West Conference, 5565 Brookville Road, Indianapolis, Ind.

Nov. 20-22
Instrument Maintenance Short Course sponsored by the Los Angeles Harbor Junior College and the Southern California Meter Association at Long Beach, Calif.

Dec. 3-5
Annual Meeting and Exhibits, Society for Experimental Stress Analysis, Hotel McAlpine, New York City. For information write W. M. Murray, Sec.-Treas., P.O. Box 168, Cambridge 39, Mass.

1953

Jan. 14-16
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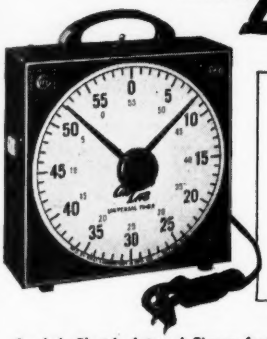

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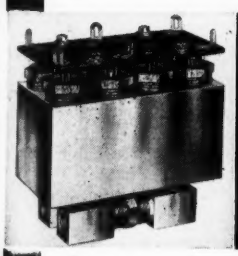

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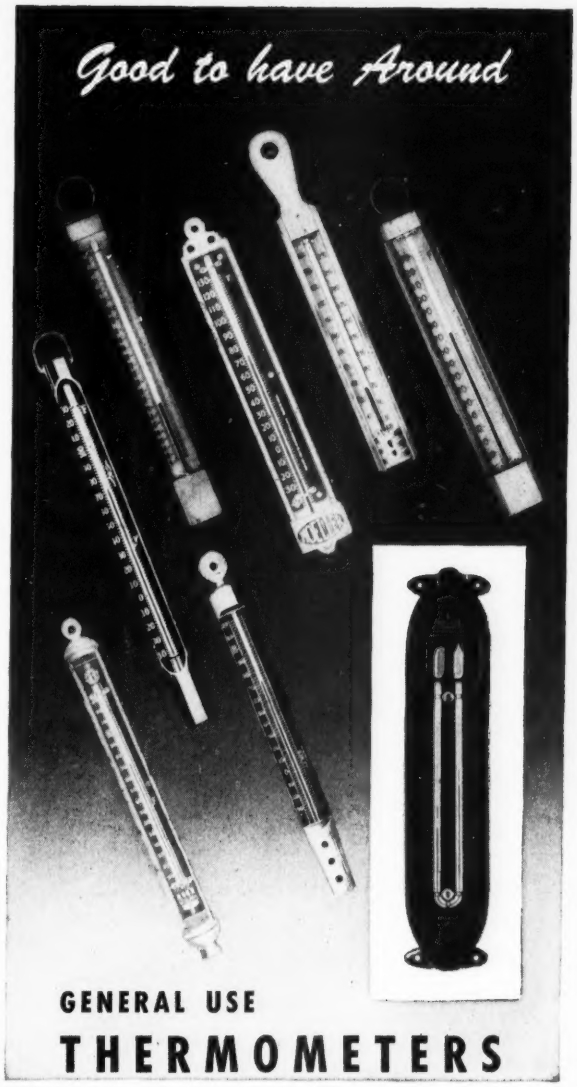

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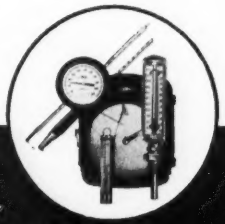

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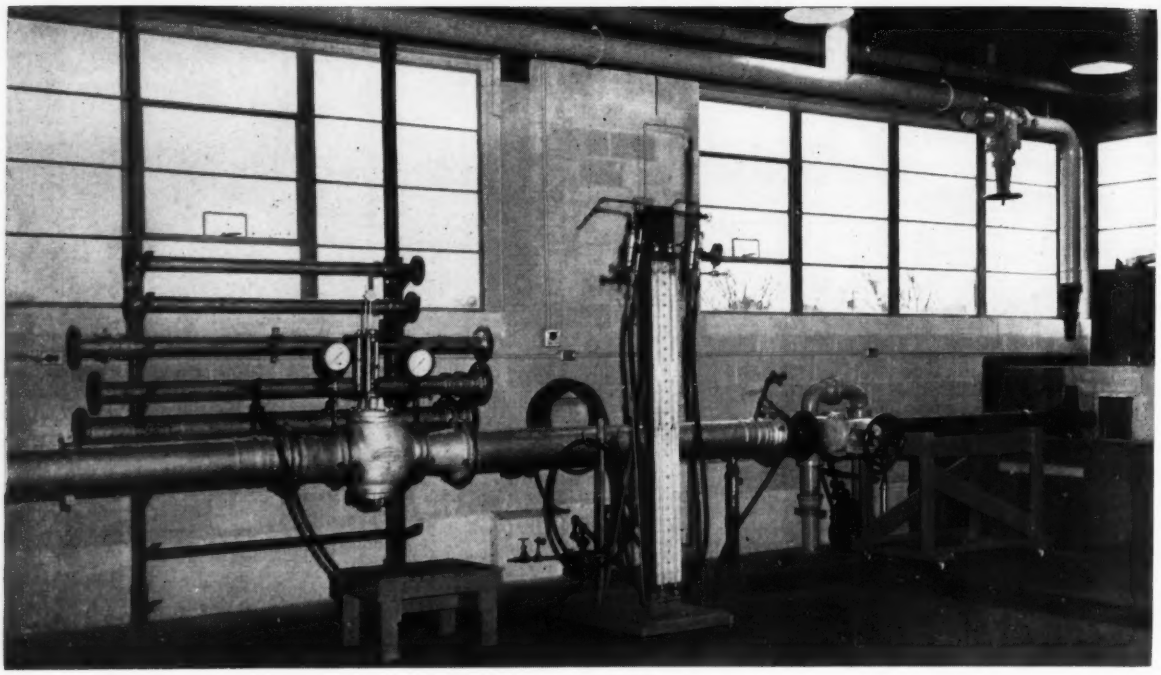


Test laboratory for control valves

VALVE RANGEABILITY

By RALPH A. ROCKWELL, Mason-Neilan Regulator Company

Without qualifications, rangeability is an ambiguous term. With qualifications, it becomes a basic valve parameter.

RANGEABILITY of a control valve is defined as the ratio of the maximum controllable flow to the minimum controllable flow. This definition is abstract and without qualification. A control valve with a soft seat could be said to have a controllable flow range from zero to maximum and, according to the definition, infinite rangeability. This obviously is not the intent but, without some qualification, all control valves have a rangeability limited only by the leakage flow in the closed position.

There are indications that rangeability was used originally to describe the reduction in the controllable flow ratio that occurred when the valve was installed in series with system drop. Today rangeability appears to be accepted as an inherent property of the control valve. This property is not altered by the physical conditions of the valve installation or the operating condtions of the system, and it is not affected by pressure drop in series with the valve.

Rangeability may be an idealized attempt to describe an intangible property of a control valve. It is doubtful if any practical method can be developed whereby the actual test performance of a commercial valve can be analyzed easily or compared to this theoretical, or ideal, property.

This article presents first the theoretical aspects of rangeability, and second the practical considerations affecting the flow range.

Presented at the New Jersey Section, Instrument Society of America Symposium, "Use and Application of Control Valves," April 1, 1952.

Theoretical Aspects

Rangeability is defined as the ratio of the maximum to the minimum controllable flow. It is generally expressed by a number such as 50 to 1 or 25 to 1. This practice necessitates several assumptions and there is a wide divergence of opinion regarding the limitations of these assumptions. If the definition is taken literally, the only problem in determining the rangeability of any valve would be to determine the actual value of the maximum and minimum controllable flow.

Let us consider a simple single-seated skirted-type valve which has a C_v* of 100 at rated lift and, when brought down "just off the seat," a C_v of 2. The phrase "just off the seat" brings in the first qualification or limitation of the basic definition. From the theoretical standpoint, a control valve requires no seat. The minimum controllable flow is determined by the clearance between the plug and the seat ring.

As the accepted definition of rangeability involves only maximum and minimum flow, a series of flow curves can be drawn on semi-log paper from 2 to 100 flow units. Fig. 1 shows three such curves drawn at random. Each can be said to have a rangeability of 50 to 1. It is doubtful that many people would accept these curves as representing 50 to 1 rangeability. The missing element, which reduces the definition to absurdity, is the flow characteristic or the

*(The symbol "Cv" is the flow coefficient—that is, the flow rate in gpm. through the valve for a 1-psi. differential across the valve.)

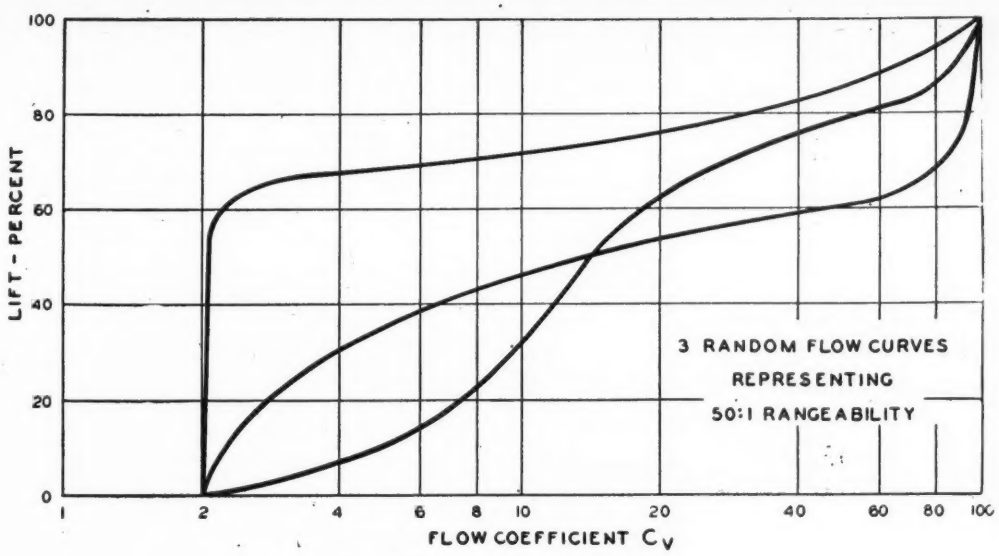
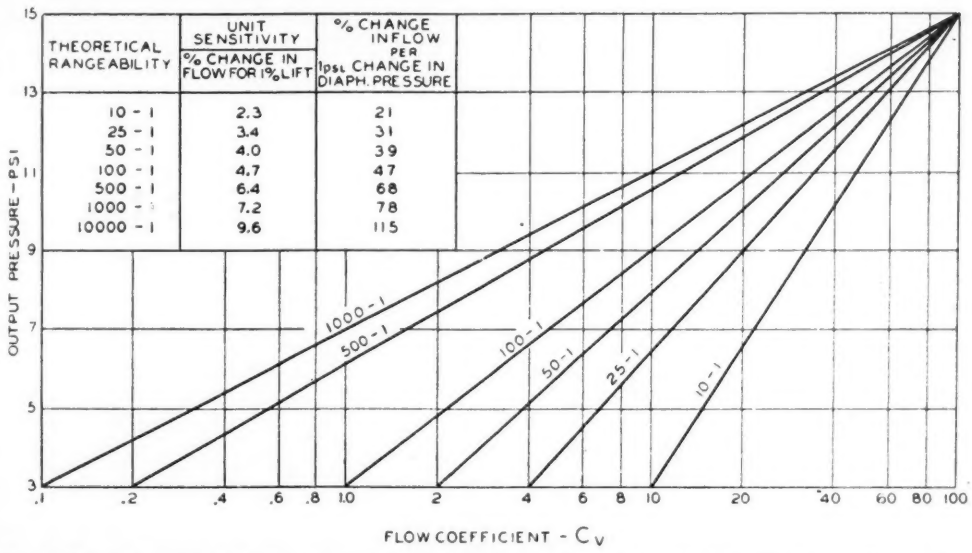


Fig. 1. Three curves with 50:1 rangeability.

CHANGE IN FLOW PER PSI CHANGE IN DIAPHRAGM PRESSURE
(12 PSI FOR FULL STROKE)



THEORETICAL RANGEABILITY	UNIT SENSITIVITY % CHANGE IN FLOW FOR 1% LIFT	% CHANGE IN FLOW PER 1psi CHANGE IN DIAPH. PRESSURE
10 - 1	2.3	21
25 - 1	3.4	31
50 - 1	4.0	39
100 - 1	4.7	47
500 - 1	6.4	68
1000 - 1	7.2	78
10000 - 1	9.6	115

Fig. 2. Flow rate versus diaphragm pressure for equal-percentage valves of various rangeability, and table of valve sensitivities.

behaviour of the valve between the minimum and maximum flow.

Flow Characteristic

We assume that the originator of the term "rangeability" intended to tie it in with flow characteristic. The inclusion of the flow characteristic is the only way that rangeability can be made to have real meaning. The implication is that rangeability really should mean the *flow range in a valve through which a particular flow characteristic is maintained.* The problem now becomes one of identifying and describing a particular flow characteristic and establishing permissible deviation from the ideal.

The literature is full of idealized flow curves, the most common being the 50-to-1 equal-percentage and linear curves. An analysis of the ideal curve points up the problem of qualifying deviations. The equal-percentage curve is more convenient for this analysis because the curve is a straight line on semi-log paper. In Fig. 2 a series of equal-percentage curves is shown having various rangeabilities. These curves are plotted in terms of C_v, the flow coefficient, against the 3-15 psi. standard I.S.A. diaphragm-motor range.

Valve Sensitivity

The slope of the curves is an indication of the sensitivity of the valve. This sensitivity may be expressed as percentage change in flow for unit change of lift. The percentage change in flow is tabulated in Fig. 2 for 1 percent change of total lift and also for a 1-psi. change in diaphragm pressure. Note that a 1-psi. change on the diaphragm is 1/12, or 8⅓ percent, of the total lift.

The 50-to-1 equal-percentage valve produces an increase in flow of 4 percent for 1-percent change in lift, and a 39 percent change in flow for any 1-psi. change in diaphragm pressure between the range of 3 to 15 psi.

With a rangeability of 10 to 1, a 1-psi. increase in dia-

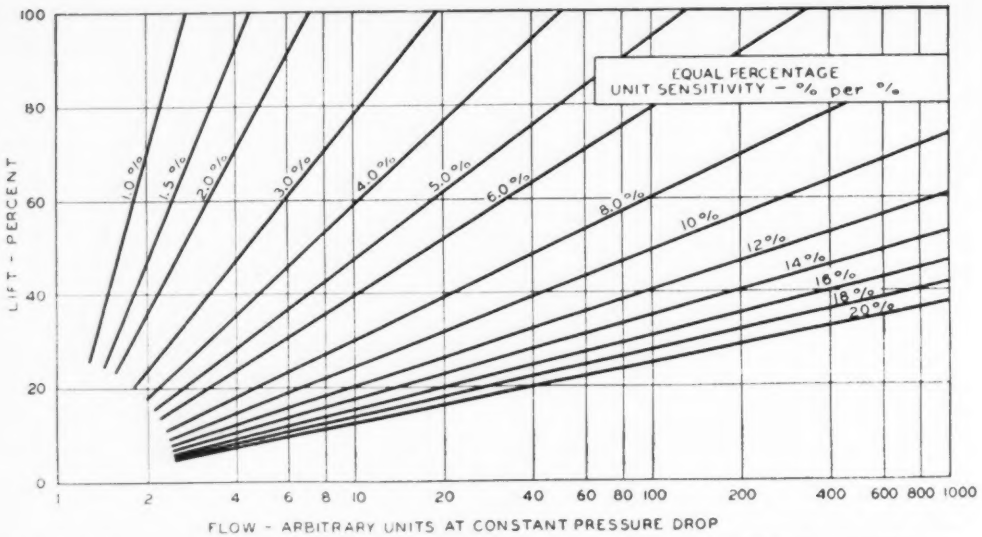


Fig. 3. Flow-lift curves of equal-percentage valves; the number on each curve is the unit sensitivity in percent flow per percent lift.

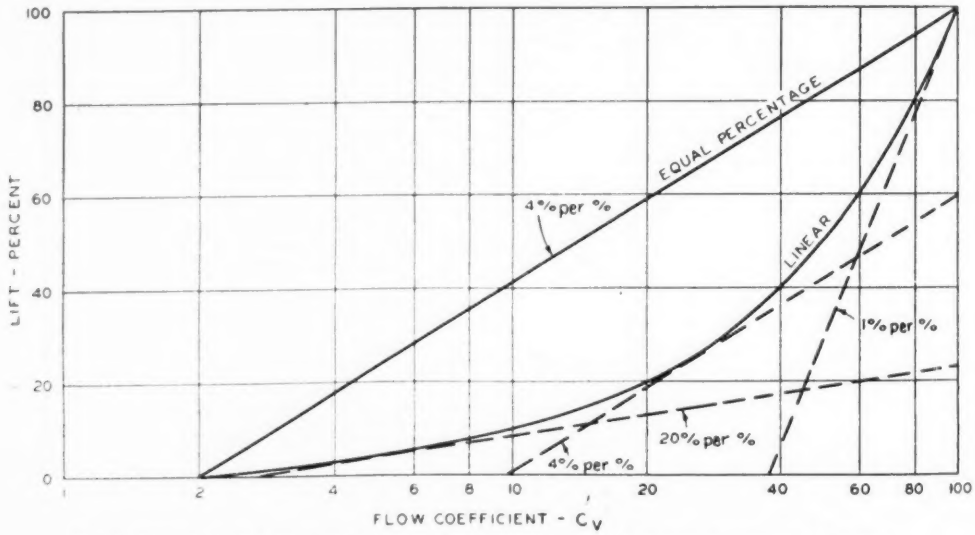


Fig. 4. Comparison of a linear valve and an equal-percentage valve, both with rangeability of 50 to 1.

phragm pressure increases the flow 21 percent; if the flow is 100 gpm, a 1-psi. increase in diaphragm pressure increases the flow to 121 gpm. A rangeability of 50 to 1 causes the valve to increase the flow 39 percent for 1-psi. change, or from 100 gpm. to 139 gpm. Therefore, the sensitivity of a 50-to-1 valve is only slightly less than double the sensitivity of a 10-to-1 valve.

As any straight line on semi-log paper has an equal-percentage characteristic, a family of lines can be drawn as in Fig. 3. Each line originates for convenience at 1.0 unit of flow; the log scale is in units of flow and the ordinate is in terms of percent lift. These lines can be identified by their unit sensitivity in percent flow per percent lift. Fig. 3 shows sensitivities from 1.0 to 20 percent per percent. This graph covers a rangeability of 1 to 2.7 (1.0 percent) to 1 to 81,000,000 (20 percent). This last number may sound too large, but a perfect 50 to 1 linear valve has approximately this sensitivity at 5-percent lift.

The graph of a perfect linear valve and a perfect equal-percentage valve, both with a flow range of 50 to 1, is shown in Fig. 4. The equal-percentage valve has a constant sensitivity of 4 percent per percent throughout the entire lift. The unit sensitivity of the linear valve depends on the lift; the dotted tangent lines indicate the sensitivity in percent flow per percent lift at three lift points. By drawing a sufficient number of tangents, points may be obtained for a continuous curve of unit sensitivity vs. lift. Such a rate curve for the perfect linear and perfect 50-to-1 equal-percentage valve is shown in Fig. 5.

These curves may be valuable in the analysis of control-valve behaviour. The original work along these lines was done by C. E. Mason* using sensitivities in percent flow change per psi. By applying the tangent method to actual valve flow curves, a sensitivity curve can be obtained which may be useful in defining rangeability and flow characteristics.

The varying unit sensitivity with lift of the linear valve complicates the analysis of flow behaviour. At 100-percent lift the unit sensitivity is 1-percent flow per 1-percent lift, which would correspond to an equal-percentage valve with a rangeability of 2.7 to 1. At 25-percent lift the unit sensitivity is 4 percent (rangeability 50 to 1) and at 5-percent lift the unit sensitivity is 20 percent (rangeability 81,000,000 to 1).

* C. E. Mason, Control Consultant, Watertown, Connecticut

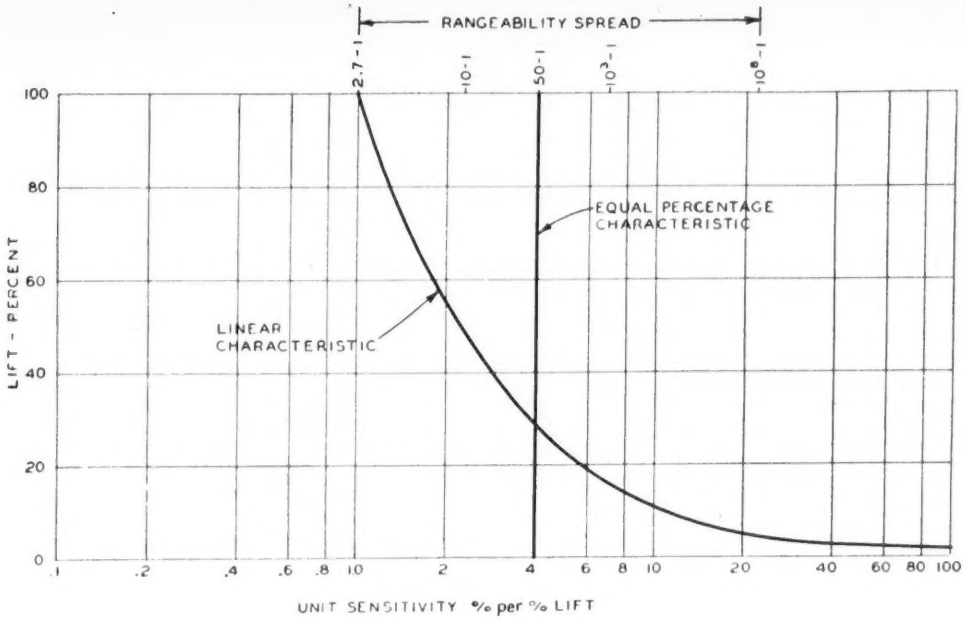


Fig. 5. Unit sensitivity of linear valve and equal-percentage valve.

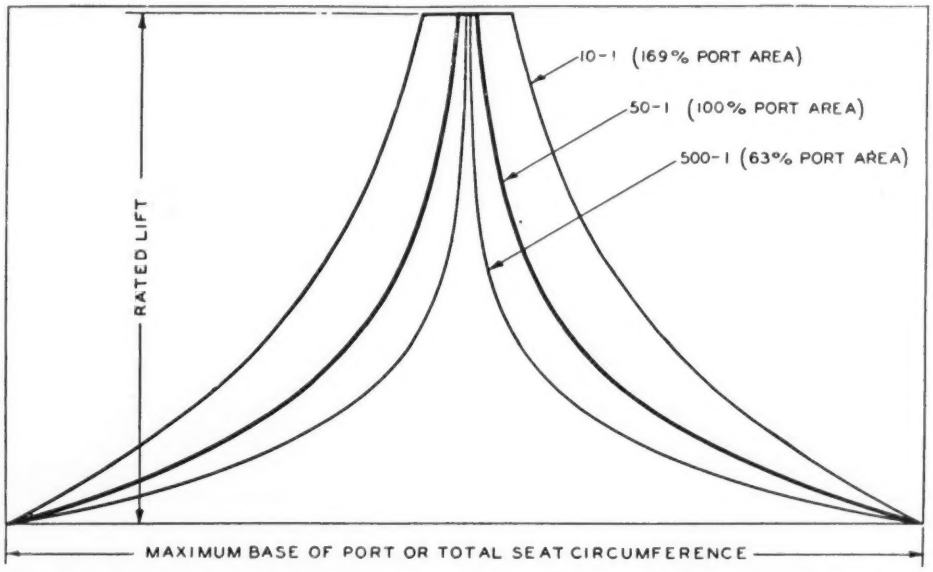


Fig. 6. Comparisons of port dimensions for valves of various rangeabilities and equal port-seat circumference.

Determination of Rangeability

As assuming rangeability in a valve implies a definite flow characteristic, how can one determine the actual rangeability of a valve? It is physically impossible to produce a perfect 50-to-1 equal-percentage characteristic in all sizes of conventional valves and at the same time maintain the present flow capacities. There are two major limitations. The first is a mathematical limitation in the *perfect* equal-percentage range obtainable in any given commercial valve. The second complication is the body loss which is in series with the ports. This loss is negligible at low lifts but must be compensated for as the plug approaches rated lift.

The mathematical limitation is shown in Fig. 6. The height of the rectangle is the lift of the valve; the base corresponds to the circumference of the seat (or seats if a double-seated valve is under consideration). In this rectangle is drawn a perfect 50-to-1 equal-percentage port. Also shown are two ports indicating 10-to-1 and 500-to-1 equal-percentage rangeability, all utilizing full lift and full seat circumference.

The maximum port area of a given valve is established by the ring diameter and the lift. This is true whether it is single seated or double seated and with any type of plug. Pictorially, this is shown best by a skirted-plug construction. The maximum area available is the lift times the seat-ring circumference. Fig. 6 shows a single port for simplicity, but multiple-port openings would not provide any additional area. With the altitude and the base of the area established, the unit sensitivity (or the rangeability, such as 50 to 1) determines the port contour and consequently the maximum port area. To increase the port area it is necessary to reduce the rangeability, as shown by the 10-to-1 port. Conversely, to increase rangeability (500 to 1), we must sacrifice the maximum port area and the maximum flow capacity.

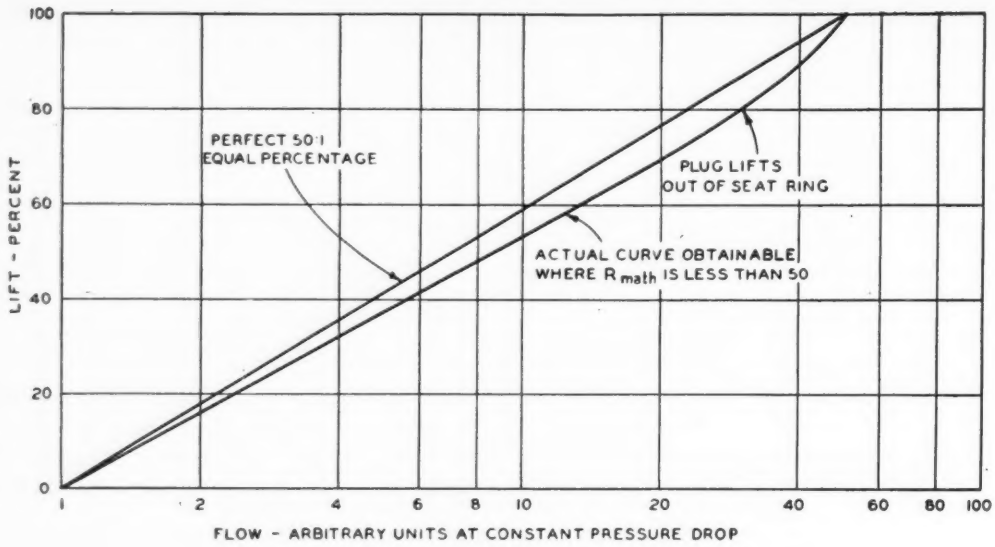


Fig. 7. Typical valve characteristic for a large valve.

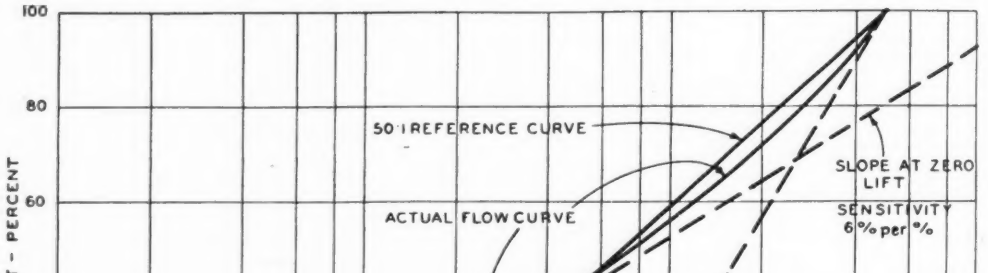


Fig. 8. Typical flow characteristics of a large valve compared with a perfect 50:1 curve.

Theoretical Rangeability

As shown in the appendix, the theoretical equal-percentage rangeability of any valve (R_{math}) is the number having its natural logarithm equal to:

total seat circumference × *rated lift/max. port area.*

That is,

$$\log_e R = X_{max}\, Y_{max}/A_{max}.$$

In a 1-inch double-seated valve, for example, assume two 1-inch-diameter seats and ½-in. rated stroke. With the maximum port area set at 75 percent of nominal line area (0.6 square inch):

$$\log_e R_{math} = 6.28 \times 0.5/0.59 = 5.32$$
$$R_{math} = 205 \text{ to } 1$$

For a 4-inch valve with 1½-in. lift and two 4-inch seat rings:

$$\log_e R_{math} = 25 \times 1.5/9.4 = 4.0$$
$$R_{math} = 55 \text{ to } 1$$

For a 10-inch valve with 2½-in. lift and two 10-inch rings:

$$\log_e R_{math} = 62.8 \times 2.5/5.9 = 2.66$$
$$R_{math} = 14.3 \text{ to } 1$$

If the lift on the 10-inch valve were increased to 5 inches, the R_{math} would be the same as for the 1-inch valve. The problem is that valve stroke does not increase proportionately with size.

Rangeability of Large Valves

An R_{math} of 14.3 to 1 sounds pretty tough, but it is logarithmic and a simple compromise yields practical port design. Mechanically, the valve plug is lifted out of the seat toward the end of the stroke and the rate of port area change becomes a constant up to rated stroke. The resultant flow curve, shown in Fig. 7, is curved at the upper end and displaced to the right through most of the stroke. The unit sensitivity at lower lifts has been increased to compensate for the fact that the unit sensitivity can not be maintained at the end of the stroke.

This is the general characteristic of most of the larger equal-percentage valves and it may be seriously accented by the effect of body restriction if an attempt is made to obtain an excessive C_v rating. In a 4-inch valve, for example, the rated flow-coefficient might be realized with only 60 percent of nominal line area in the ports and the extra 15 percent is added to compensate for body loss. This means that

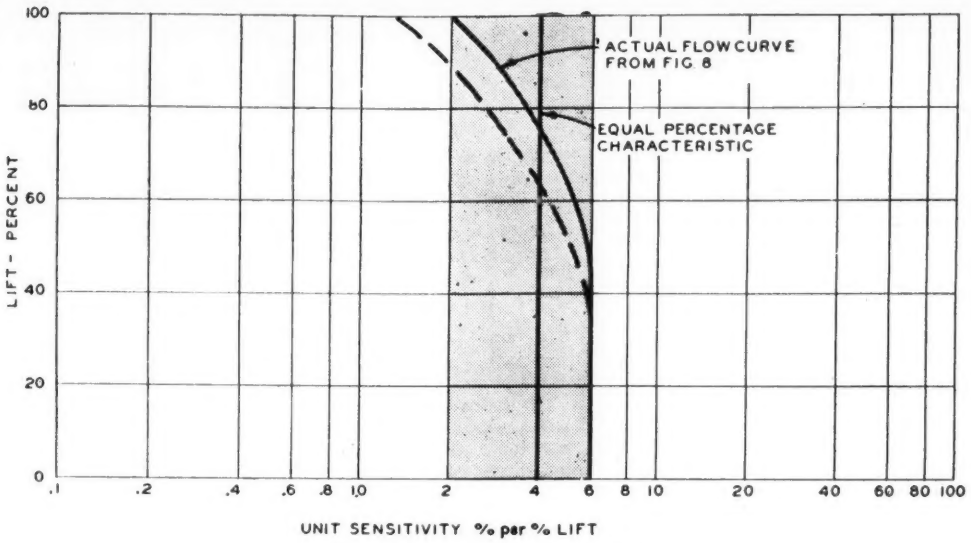


Fig. 9. Sensitivity curves of large valves.

the maximum mathematical rangeability must be well above 50 to 1 if a perfect 50-to-1 curve is to be obtained.

These limitations and other practical factors in large size valves complicate the problem with the result that an actual characteristic of a 50-to-1 equal-percentage valve may be as in Fig. 8. The tangents to the curve represent the unit sensitivity of the valve at that point. Two such tangents are drawn. The one at zero lift indicates the greatest unit sensitivity; the one at 100-percent lift the minimum sensitivity. By comparing the slope of these lines with the lines in Fig. 3, the actual sensitivity is seen to be about 6 percent per percent maximum and just over 2 percent per percent minimum.

By drawing a number of tangents, points may be obtained for a unit sensitivity vs. lift curve for the actual flow curve of Fig. 8. This is shown in Fig. 9. If permissible variations or tolerances were established around plus or minus 2 percent per percent, this valve could be said to have a flow range of 100 to 1 with a rated unit sensitivity of 4 percent per percent. If the change in unit sensitivity had been as shown by the dotted line, the valve would have exceeded the limits at 90-percent lift and (by reference to Fig. 8) the flow range would be 0.5 to 38 units of flow (a flow range of 76 to 1) with a rated unit sensitivity of 4 percent per percent.

Practical Considerations

Although it is possible to consider the design of a valve plug as an exercise in pure mathematics, in practice we resort to a combination of mathematical empirical expressions and experimental coefficients. It is well to have some familiarity with the work on which the experimental factors are based in order to judge the application to the valve at hand. Many experimental factors are uncertain in the second significant figure; there are factors or coefficients that are uncertain in the first significant figure. Test results are frequently valueless unless the test procedures and physical equipment are outlined in detail.

There are three factors that must be considered with respect to the flow range of a control valve—(1) the minimum controllable flow and leakage flow, (2) the maximum flow, or capacity, and (3) the flow behaviour between minimum and maximum flow.

Minimum Controllable Flow and Leakage Flow

The leakage flow (with the plug just off the seat) is directly proportional to the clearance between the plug and the seat ring (Fig. 10). This clearance is determined largely by the mechanical problem of alignment between the various

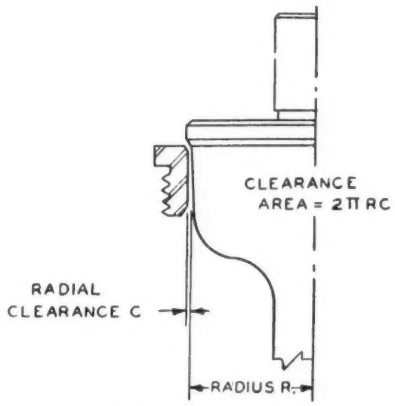


Fig. 10. Details of plug and seat ring.

body sub-assembly components with an allowance (based on long experience) to take care of operating temperature extremes.

With the plug just off the seat, the passage open to flow is an annular ring which is very narrow with respect to the seat-ring diameter. For this shape, the port area is equal to 2π times the seat ring circumference times the clearance ($2\pi RC$). For a double-seated valve the clearance is the sum for both rings.

A double-seated 2-inch control valve has a diametrical clearance of approximately 0.003 to 0.005 inch. The area with a radial clearance of 0.002 inch equals

$$2\ (2\pi RC) = 2\ (6.28 \times 1.0 \times 0.002) = 0.025 \text{ sq. in.}$$

The C_v of 1 square inch with 0.8 efficiency is 30. Therefore, the C_v of 0.025 square inch theoretically should be about 0.75. If the rated C_v of a 2-inch valve is 50, it is apparent that a flow range of 50 to 1 is within practical attainment. The minimum controllable flow normally can be considered to be slightly in excess of the leakage flow and, therefore, above the point of an abrupt change in sensitivity as the plug attempts to throttle on the seats. Under test it can be demonstrated that a 2-inch double-seated valve with the plug just off the seat will give a 1.0 C_v or less while meeting all other practical requirements for a commercial valve.

As the valve size is increased, the problem of maintaining low leakage flow (percent of maximum capacity) is some-

Continued on page 1126

MULTI-POINT RECORDING

A stepping switch and control circuit increases capacity of a 16-point potentiometer recorder to 240 points.

By JOHN G. TAYLOR*

ELECTRONIC potentiometers are at present most readily available in models capable of automatically recording temperatures from not more than sixteen thermocouples. In some instances more thermocouples are needed to accurately follow a rapidly-changing or widely-varying process.

The need for many more thermocouples arose when a study was started in 1949 by the Farm Electrification Division of the Bureau of Plant Industry, Soils and Agricultural Engineering, the North Central Regional Bee Culture Laboratory, and the University of Wisconsin Agricultural Engineering Department, on the possibility of improved bee cultural practices by the application of electric heat to beehives. In order to determine the effect of applying heat to beehives, a temperature study was necessary to "see" into the beehives. Because bees form clusters at certain temperatures and the effect of the heat upon the clusters is needed, thermocouples had to be located throughout the hive to be sure that the temperatures of a cross section of the clusters would be recorded.

As these clusters vary in size and position in the hive body, as many as 240 thermocouples were required to accurately plot the movement of the bees in a single hive. It was also necessary to have these temperatures taken on a 24-hour schedule to get cyclic effects.

After investigating commercially available basic switching units, it was decided that a stepping switch made by the C. P. Clare & Co. of Chicago would provide the action needed. Such switches were then available in maximum sizes of eight levels with twenty steps. These switches are essentially electrically-actuated rotary switches, each level consisting of a separate 20-position switch (see Fig. 1).

The simplified circuit shown in Figs. 2 and 3 is similar to the one developed for the beehive application. The circuit shown, however, has only one 8-level 20-step switch which would provide switching of 160 couples for an eight-point potentiometer recorder. The actual recorder used was a Brown "ElectroniK" 16-point potentiometer, and a second stepping switch was used in parallel to provide a total of 320 points, automatically switched.

Description of Circuit

Fig. 2 shows a schematic diagram of the control circuit and connections to the recording potentiometer.

According to directions furnished by the manufacturer of the potentiometer, the potentiometer amplifier switch, S1, is left on continuously except for shutdown periods extending over one week in length. A time clock controls the printer and switching circuit, permitting reports to be made at specified intervals, such as periods of every four hours, rather than continuously. Switch S2 by-passes the time clock switch in order to permit manual control. The time clock, of course, may be omitted if continuous records are desired.

When time clock switch S2 is closed, the printing and switching circuit is energized. The potentiometer's integral rotary switch makes one complete revolution while selecting and printing individually, in sequence, thermocouples 1 through 8, then repeats. A Micro-switch, S3, is mounted on the rear of the potentiometer and is actuated by the rotation of the potentiometer switch drive shaft. An existing pin extending from this shaft may be used to actuate the Micro-switch which is so adjusted in relation to the shaft that the switch is momentarily closed while the potenti-

* Agricultural Engineer, Division of Farm Electrification, U. S. Department of Agriculture (Agricultural Engineering Bldg., Purdue University, Lafayette, Indiana).

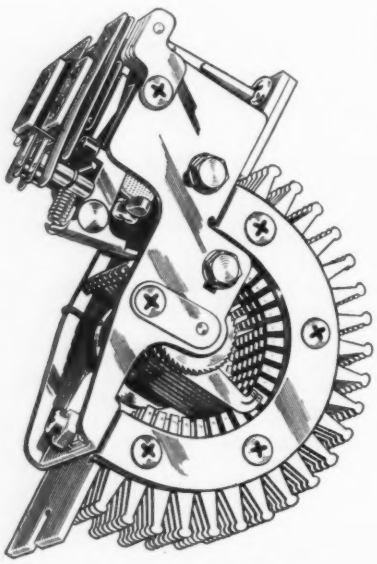


Fig. 1. The "Type 20 SD-48" eight-level 20-step stepping switch used in the circuit described. The contacts are especially gold-plated in order to minimize contact resistance. (Illustration courtesy C. P. Clare & Co., 4719 Sunnyside Avenue, Chicago, Illinois.)

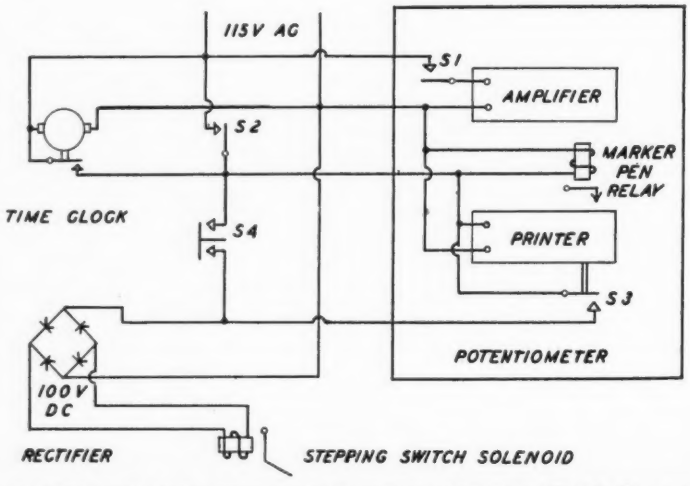


Fig. 2. Control circuit showing connections to the recording potentiometer. The 115-volt a-c. marker pen relay and the Micro-switch, S3, are mounted in the potentiometer. Switch S2 is a toggle switch; and switch S4 is a momentarily-close, pushbutton switch. The rectifier is a selenium full-wave bridge type. All parts required for this circuit, except the stepping switch, may be purchased from a radio supply company.

ometer is shifting from couple No. 8 to couple No. 1. This short impulse energizes the rectifier which, in turn, feeds the stepping switch solenoid. At the end of this impulse, the stepping switch is moved forward one position, switching a new group of eight thermocouples to the potentiometer.

Three levels, 1, 4, and 7, of the eight-level stepping switch are shown in Fig. 3. With the stepping switch wipers at step 1, as shown, the thermocouples in plug 1 are connected to the potentiometer terminals. The stepping switch remains at this position until the internal switch of the potentiometer switches to each thermocouple 1 through 8 of the group connected and prints their temperature. After couple 8 of the first plug is printed the stepping switch is energized by the momentary closing of switch S3, as previously described, and the stepping switch wipers advance one position to step 2, connecting the eight thermocouples of plug 2 to the recording potentiometer.

Plugs 1, 7, and 17, of the twenty plugs used, are shown with their connections through the stepping switch. It is evident that one separate level in the stepping switch is required for each point in the recording potentiometer, which when multiplied by the number of steps in the stepping switch, determines the total number of thermocouples which may be automatically switched.

In order to identify the various groups of couples it is necessary to have a reference marker printed. This is accomplished by feeding a reference-temperature voltage signal to the recording potentiometer. Number 1 position on step number 1, shown in Fig. 3, is not used for a thermocouple but is instead fed to a potentiometer, R1, to pick off a small potential from a 1.5-volt flashlight cell. This potentiometer is set so that a corresponding temperature mark on the chart is out of the range of temperatures being measured. Likewise, step 6 may be identified by printing number 2, step 11 by number 3, and step 16 by number 4, all printing the same reference temperature. This reduces by four the total number of thermocouples recorded. As the switching circuit is always stepped between couples No. 8 and No. 1, other points between every fifth group may be easily identified between the reference markers.

The time clock is adjusted so that a complete cycle of twenty groups is printed. When a fast-speed recording potentiometer is used, the printing time varies slightly depending upon the temperature spread of the couples. As there is no spread on the chart between time periods, a marker is required to identify the end of a particular time period and the start of another.

A 115-volt a-c. relay energized by the time clock was fitted with an inking pen and mounted at one edge of the chart in line with the printer. When the clock is energized, the relay lifts the pen off the chart, but when a particular cycle is completed, the relay drops the pen on the chart, leaving a dot at the edge of the chart as a time marker.

In case manual switching to any particular step is desired, this may be accomplished by closing S2 and pushing button S4 as many times as required to switch to the desired group. A numbered wheel located on the stepping switch shows the level making contact.

Construction

The contacts of the stepping-switch construction which carry the thermocouple circuits are gold-plated in order to minimize contact resistance. Only the copper (positive) leads are switched, a common constantan (negative) system being employed. If desired, the constantan could also be switched but twice the switching capacity would be required.

The stepping switches were mounted on a metal chassis with the switching (thermocouple) connections brought out underneath the chassis and the solenoid connections on top of the chassis. This method permitted all current-carrying conductors to be installed on the top side of the chassis, shielding them from conductors with impressed thermocouple potentials which are all underneath the chassis. It is important that the chassis be grounded to the grounding conductor of the recording potentiometer. The cabinet in which the switching mechanisms is installed should have a dust-tight cover in order to protect the stepping-switch contacts.

In the Wisconsin installation, the thermocouples were brought in groups of sixteen to female sockets on a panel mounted on the wall to the rear of the switch, as shown in Fig. 4. This panel was hinged to allow access to the rear.

Acknowledgement

The author wishes to acknowledge the aid of Mr. Albert W. Yovanovich, a former Purdue University student, and Mr. Charles D. Owens, Farm Electrification Division, U.S.D.A. now on military leave, in designing, building, and testing this switching circuit. The author also wishes to acknowledge the use of the laboratory and other facilities of the Purdue University Agricultural Engineering Department.

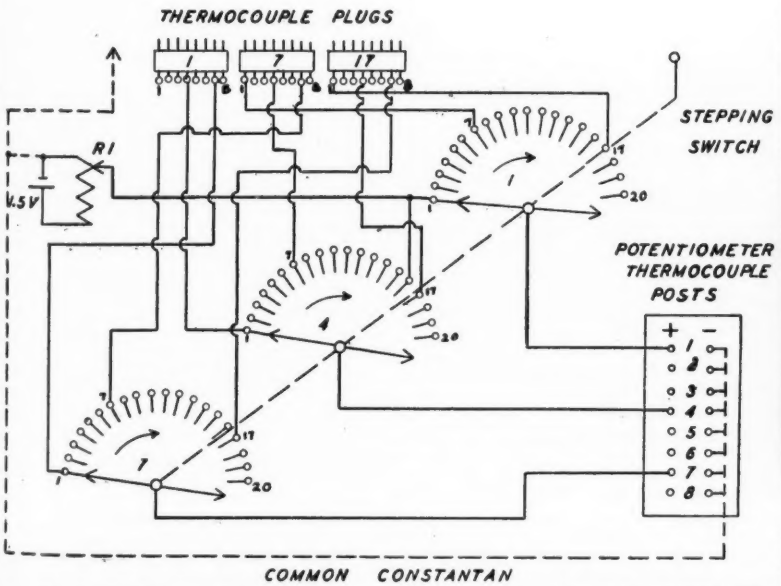


Fig. 3. The thermocouple switching circuit. Only three plugs of the twenty required, and three levels of the 8-level stepping switch, are shown. The wiper arms at each level on the stepping switch are locked together and advance one position to a new step for each electrical impulse received by the stepping-switch solenoid.

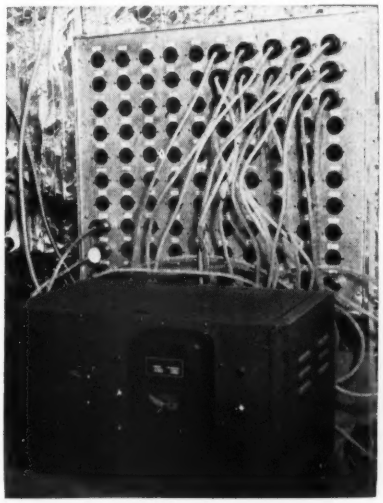


Fig. 4. The installation of the 320-point stepping switch at the University of Wisconsin. All thermocouple leads are brought to the panel board and connected in groups of sixteen to the female receptacles. The twenty patch cords are connected to the stepping switches permitting automatic recording of any group of 320 thermocouples out of the 1600 thermocouples available at the panel.

Principles of Fluid Flow

Comparison of experimental data and theoretical principles shows the necessity for experimental determination of flow coefficients. Included also is a technique, based on Venturi flow-coefficients, for sizing valves.

By DR. D. P. ECKMAN
Consultant, Conoflow Corp.

THE flow of fluids through control valves is a subject requiring special consideration because of the many factors affecting flow rate through valves. This is a type of engineering problem in which there is small hope for a purely analytical solution, and it is doubtful whether any statement regarding control-valve-flow behavior should be accepted without substantiation from experimental data. This article reviews a few fundamentals of fluid flow for control valves and then presents experimental data. The following symbols are used in the discussion:

A_1 = line area in sq. ft.
A_2 = valve port area in sq. ft.
A_P = valve port area (max) in sq. in.
C = viscosity in centipoise
C_{VT} = venturi flow-coefficient
D = valve nominal size in inches
D_1 = line diameter in feet
D_2 = equivalent diameter of port opening in feet
f = line-friction factor
g = 32.2 ft./sec./sec., the acceleration due to gravity
G = specific gravity of fluid flowing
K = valve flow co-efficient
L = line length in feet
N_R = Reynolds number
P_1 = static pressure in line
P_2 = static pressure in valve port
ΔP = valve pressure drop
ΔP_L = line pressure drop
Q = flow rate in gpm. or cfs.
V_1 = velocity in line in fps.
V_2 = velocity in valve port in fps.
γ = weight density of fluid flow
ν = kinematic viscosity in ft.^{2} per sec.
π = 3.1416

Fundamentals of Fluid Flow

Consider the flow-restricting device in Fig. 1 as a form of the Venturi tube. In order to analyze the flow behavior it is necessary to assume (1) steady flow, (2) an incompressible fluid, (3) no losses due to either viscosity of fluid, changes of direction, enlargement, or contractions, and (4) no heat transfer.

With these assumptions, the law of conservation of energy is:

$$V^2_1/2g + P_1/\gamma = V^2_2/2g + P_2/\gamma \quad (1)$$

The continuity relation (law of conservation of mass) is:

$$Q = A_1V_1 = A_2V_2, \quad (2)$$

Eliminating velocities in (2) by use of (1):

$$Q = [1/(1/A^2_2 - 1/A^2_1)]^{1/2} [2g(P_1 - P_2)/\gamma]^{1/2} \quad (3)$$

However, in an actual test with a control valve this relation may be found to be in error by as much as 80 percent (low) or 20 percent (high) depending on the flow rate, pressure drop, and nature of the flowing fluid. Obviously either the theory is inadequate or the assumptions have been violated. Actually, for a control valve, the third assumption (that there are no losses) cannot be expected to hold because any control engineer knows that it is desirable to have an appreciable pressure drop across a control valve. Indeed, this is almost the entire difference between a control valve and a hand valve.

The losses in the control valve due to viscous effects of the fluid and changes in fluid-stream velocities probably could be acounted for and the flow equation corrected. However, as we are going to base the flow rate on experimental data, it is possible to use a much simpler equation. As in the calculation of orifices, nozzles, and Venturi tubes we assume that the flow is given by:

$$Q = KA_2\sqrt{2g\ (\Delta P)/\gamma} \quad (4)$$

where the flow coefficient (K) is the "fudge factor" to make the equation come out right. In practical use it is included in the "C_v factor," which is defined as the flow rate (gpm.) of water for a pressure differential of one psi.

Line Losses and Body Losses

The ideal control valve should have a constant pressure drop (ΔP) and a constant flow-coefficient (K); then the flow would vary directly with area of opening. However, even this simple solution does not exist because the loss in the line in which the valve is installed varies with flow rate, the loss in body passages varies with flow rate, and both of these vary with area of opening. In addition, viscous-friction losses vary with flow rate and with characteristics of fluid.

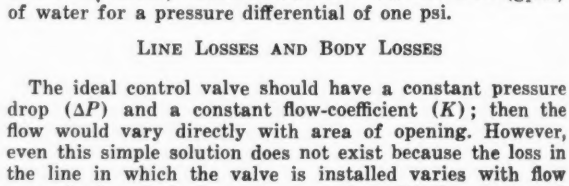


Fig. 1. A flow restriction.

Line losses always reduce the pressure drop across the valve and they should never be neglected in control-valve calculations. Line losses depend on line size, line length, line velocity, and the characteristics of fluid:

$$\Delta P_L = f(L/D_1)(\gamma Q^2/2g\ A^2_1), \quad (5)$$

where the friction factor (f) is taken from the Moody diagram and varies considerably with Reynolds number:

$$N_R = QD_1/A_1\gamma \quad (6)$$

Thus there are few installations of control valves in which the line losses are constant; they vary with flow rate and cause the pressure differential at the control valve to fluctuate with flow rate.

Body losses also reduce the pressure drop across the valve port. However they cannot be calculated because the loss depends on body passages, contours, cross-sections, etc. In general it may be assumed that the losses are proportional to the velocity to some power probably greater than two, and that the coefficient of loss also varies with velocity. As will be shown, the body losses reduce the flow coefficient considerably at high velocities.

Experimental determination of valve flow-coefficients is the only proper way to account for variation of fluid characteristics, flow pattern in the control valve, and pressure differential.

Experimental Determination of Flow Coefficients

The control-valve flow-coefficient (K) should be determined by experiment. A standard, cast-bronze, one-inch size, single-seat control valve, model AB-10, supplied by the Conoflow Corporation, was used in the test described. The

Continued on page 1144

Presented at the New Jersey Section, Instrument Society of America Symposium, "Use and Application of Control Valves," April 1, 1952.

Organization of Instrument Departments in Typical Process Industries

By SHERMAN S. SHAFFER, Humble Oil & Refining Co.

History

INSTRUMENT departments of the process industries have undergone growth and development during the past 25 or 30 years that has paralleled the evolution of instrumentation as an essential adjunct to successful process operations. In the early twenties it would have been difficult to find the instrument departments in most plants. However, with the advent of continuous processes in which control of conditions was of the utmost importance, it was necessary to measure temperature, pressures, liquid levels, and rates of flow continuously. Thus, in the early twenties, instrumentation as we know it today began to develop, and the installation and maintenance of these instruments began to be a function of a group of specialists. This was the beginning of the modern instrument department.

In our own plant, the Baytown Instrument Department was organized in 1925 with five men from the machine shop and one "pyrometer man." By 1935 the Department had increased from the original six-man crew to a group of 35. This increase was much more than proportional to increased crude runs, which rose from 40,000 to 100,000 barrels a day during the same period. The organization reached a peak of 170 men during World War II, and at present numbers about 145, even though crude runs are in excess of 250,000 barrels a day as compared with 185,000 barrels a day during the war. The maintenance of a greater number of instruments with fewer men is possible because of improvements in the design and construction of instruments, better process-unit design, a better-trained work force, and emphasis on preventive maintenance.

Instrumentation has become the "nervous system" of the complex monster units that process the vast quantities of products of the process industries. For example, the huge fluid catalytic cracking units of the petroleum refineries, circulating powdered, solid catalyst at a rate of 40 tons per minute, and with lines and vessels set in a structure 20 stories high, can not be operated manually. Automatic instruments permit instant response at the operator's touch, and 36-inch valves can be operated from distances of hundreds of feet. Fractionating towers today separate hydrocarbons that boil in such a narrow range that a variation of one-quarter of a degree Fahrenheit would throw the product stream off-test; thousands of dollars per day in product depend on the precise control of such operations.

The design, selection, installation, and maintenance of the instruments that are such a vital part of today's process installations are the functions of the modern instrument department and of staff personnel having special training and experience in the field of instrumentation.

Principles of Organization

Instrument departments are relatively new. They are young organizations, manned by young men. In some industrial establishments they have been planned; in some they have just grown. Probably none of us will have the opportunity to set up a department starting from grass roots, but many of us participate currently in the day to day growth and adaption of departments to meet changing needs. Therefore, let us review some of the basic principles of good organization. The same principles apply to the intelligent management and development of an existing organization as apply to the establishment of a new organization.

Presented at the Seventh Annual Symposium on Instrumentation for the Process Industries, Texas A & M College, College Station, Texas, June 2, 1952.

A Master Plan

Most of us, when faced with organizational problems, say to ourselves, "Now, we have such and such personnel; how can we build the organization around these individuals and make it efficient and effective?" This is the wrong way to start.

Start with an ideal. Whether the problem is the setting up of an entirely new organization, or the direction of an established organization, the first thing to do is to outline the best possible arrangement to accomplish the job. This best possible arrangement must be set up without any regard to the individual people that must be utilized. Forget, for the moment, John Brown and Bill Smith. They come later. Even in the oldest and most rigidly established organizations there are opportunities for change. Bill Smith may retire, or John Brown may unexpectedly develop new capabilities. New demands may be made upon the organization; growth and development may lead to changes in functions and responsibilities.

Having made up the plan and established an ideal organization, we then turn to the personnel available and fit them into it as best we can. As we are now dealing with human beings, we cannot achieve perfection. But, if there is a master plan toward which the organization is pointed, changes can be made when the opportunities come. Without a plan to work toward, we make day-to-day decisions and find ourselves making no progress toward improving the organization.

Determine Types of Work

Let us review the principles of organization that we should keep always before us. First, determine the kinds of work that need to be done. This might appear self-evident, but it should be mentioned at the start. Just what is the organization expected to do? Is the instrument department to be solely for the maintenance and repair of instruments? Or is it to include participation in the selection of new instruments, decisions as to types of instruments and instrument installations, and participation in the design of instrumentation on new installations? If such activities are contemplated, should they be carried out by instrument engineers who are a part of the line organization of the department, by staff personnel assigned to the department, or by other staff groups? Here is a simple question that has no simple answer: What is an instrument? Many types of work can be done in the instrument department that involve equipment that is not process instrumentation; repairing electric clocks or candy vending machines are examples.

Divide and Define Responsibilities

Having decided what kinds of work need to be done, the next step is to group jobs that are related. This is the division of responsibility that is necessary in an efficient organization. Here we must keep in mind that the number of subordinates that report to one person should be based on the complexity, variety, and proximity of the jobs involved. This grouping of related jobs is a natural and logical step. But it must be watched or we find jobs being done by the wrong people or perhaps not being done at all.

The next step is to define the responsibilities and extent of authority of the various members of the organization. This may be called the delegation of authority. *Give every individual sufficient authority to accomplish the responsibility assigned to him.* Authority may be delegated but re-

sponsibility never can be. There must be no overlapping of authority.

Now we are ready to draw an organization chart showing the lines of authority. This chart should follow the principle of unity of command. Every employee should have only one person to whom he reports and from whom he takes orders. Each should know to whom he reports and who, if anyone, reports to him. Each employee should know his place in the organization.

The organization chart should show clearly the positions of staff personnel. In a line organization there is no staff; each person has one boss and the boss has no one to assist him. In a line and staff organization, which is the more common, each person still has only one boss, but the boss has a staff man or men to help him; a supervisor directs the work of others. The staff man does not give orders to line personnel or perform line duties. If he does, he ceases to be a staff man. His job is to assist the boss and to solve special problems. He can only function successfully through tact, cooperation, and strict adherence to his staff functions.

Next we consider the complexity, variety, and proximity of the work in order to decide on the number of employees

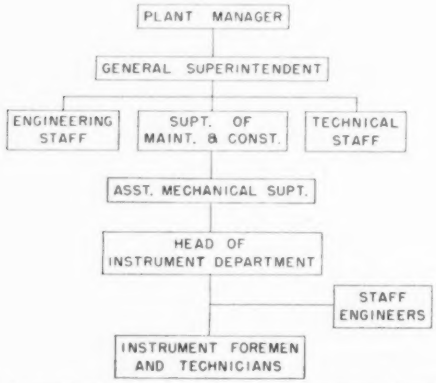


Fig 1. Conventional organization chart for an instrument department in an industrial organization.

required in each group. Remember that we considered this when we decided upon the division of responsibility.

Next we decide what equipment each worker and each group will need in order to do their work and provide for its maintenance. We establish lines for continuous and adequate flow of material and supplies, and we may wish to establish reasonable controls on financial expenditures.

Personnel

Now, and only now, are we ready to select and assign personnel. It is at this point that we have to begin modifying and making compromises with the ideal target organization. The best qualified personnel available may not be of such uniformly high calibre as to make possible attainment of the ideal. But remember that deviation from the ideal because of circumstances does not alter the ideal. The target plan should always be kept intact as a goal toward which to work. It should be modified only as the basic needs of the organization change, and not to fit the limitations of available personnel. It should be a structure, not fixed and frozen, but a structure that at all times represents the best way in which the organization could be set up to accomplish its ends.

So far we have talked in very general terms about organizational principles. Let us now examine some instrument departments in specific process industries.

The management of seven establishments in the Gulf Coast area have contributed to this presentation by permitting discussion of the organization and functions of the instrument departments in their plants. Incidentally, each request was granted; there were no refusals. Those selected were the Tutwiler Refinery of Cities Service Refining Corporation at Lake Charles, Louisiana; the Dow Chemical Company, Texas Division at Freeport, Texas; the E. I. du Pont Company, Sabine River Works, at Orange, Texas; the Baton Rouge Refinery of Esso Standard Oil Company, Louisiana Division at Baton Rouge, Louisiana; Baytown Refinery of Humble Oil and Refining Company, at Baytown, Texas; Monsanto Chemical Company, Texas Division, at Texas City, Texas; and the Houston Refinery of Shell Oil Company, at Deer Park, Texas. I wish to express my appreciation to the companies and their personnel for their courteous and cooperative assistance.

Conventional Organization

The organization of the instrument departments of the seven plants which were included in this study conforms to a general pattern in its broad aspects. Interesting variations are found in relation of the department to other departments of the company, in lines of communication and direction, in responsibilities and functions, in staff relationships, in methods of selection of new personnel, and in training and progression programs. These are dictated in part by the provisions of union contracts and in part by the situations and requirements in the various plants.

What may be regarded as the conventional arrangement

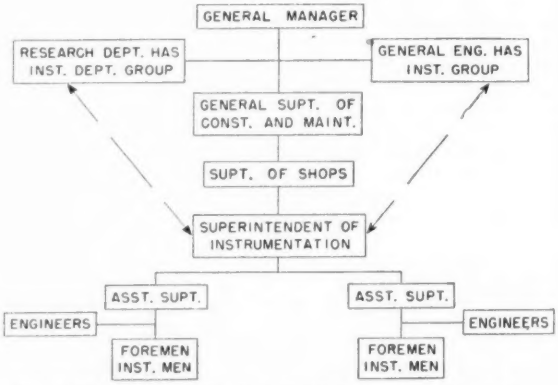


Fig. 2. Organization of the Dow Chemical Co., Freeport, Texas.

(Fig. 1) is a department, the head of which reports to a major supervisor in the mechanical maintenance and construction department. Depending on the size of the organization and the requirements of the local situation, there may or may not be one or more assistant department heads. The main body of instrument men usually is divided into groups that report to foremen or to leadermen. (Because job-classification titles tend to be arbitrary and confusing, the term "instrument men" is used throughout this article to include the members of the working force, except when the use of actual job titles is helpful in the explanation of the organization and functioning of individual departments.)

Without exception there are functions either within the department itself or in related departments that are properly designated as staff activities. These functions can be classified broadly as engineering and development. Whether these are carried out by members of the instrument department or by members of other groups, they are essential to the attainment of the objectives of an instrument department in any large, modern industrial establishment. Engineers serving in staff capacities are found in several instrument organizations; in others the engineering functions are carried out by members of the general engineering departments; in some there are men in staff positions other than engineering whose background of experience makes them valuable as advisors to the instrument department. In no plant was research and the development of entirely new types of instruments found to be a responsibility of the instrument department; where such work was conducted, it was properly assigned to an appropriate research organization. Most instrument departments, however, do some testing and evaluation of new instruments.

Let us now consider the instrument departments of the

seven typical process industries, taking up first the chemical plants and then the petroleum refineries.

THE DOW CHEMICAL CO., TEXAS DIVISION, FREEPORT, TEXAS

Dow at Freeport is a large and diversified chemical-manufacturing installation. Major products include inorganic chemicals such as metallic magnesium, caustic soda, chlorine and ammonia, and organic chemicals such as ethylene, carbon tetrachloride, chloroform, methyl chloride, methylene chloride, perchlorethylene, glycol, and vinyl compounds.

There are two plant areas, several miles apart, which are designated as the "A" and "B" plants. Fig. 2, a simplified organization chart of the instrument department, shows the lines of supervision and reporting, and the relation of staff groups. This is a conventional organizational set-up reporting through supervisors of the mechanical department. Total man power at present is 87.

There are five *engineers* in the department. They report to the Assistant Superintendents of Instrumentation and normally function in strictly staff capacities. One of the engineers has as a primary responsibility the evaluation and testing of new types of process-control instruments.

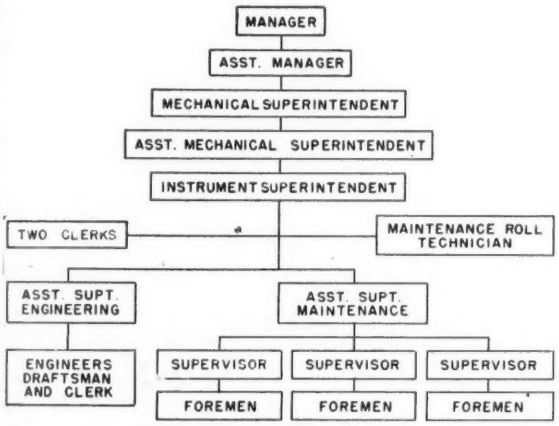


Fig. 3. Organization of the E. I. duPont Sabine River Works, Orange, Texas.

Some are active in the design of new installations, working in close cooperation with the general engineering and research groups. They also take a major part in the training program. The engineers spend a considerable part of their time on work connected with the construction of new installations. When a new processing unit is constructed, an instrument-department engineer inspects the installation of the instruments, calibrates them, and follows the start-up closely. He and a process instrument man usually spend full time on the unit for a month before the start-up, in order that both will be thoroughly familiar with the instrumentation of the operation.

The *foremen*, of whom there are five at present, are men who have advanced through the instrument department organization. Consequently they are skilled in every phase of the maintenance work. They are assigned to major operating divisions, such as inorganic, organic, and "B" plant operations. One foreman is responsible for the shop. They are assisted by fifteen lead men classified as "instrument technicians." The number of instrument technicians is dictated by the requirements of the work and promotions are made to this classification only as openings occur. The main body of about 50 instrument men is classified in conventional gradations. All men are expected to qualify with training and experience to be "instrument processmen," capable of carrying out any type of preventive instrument maintenance with a minimum of direct supervision.

Although there is an *instrument shop*, as is the general rule, an attempt is made to minimize shop work. As much as possible is sent to the mechanical craft shops. Emphasis is placed on the philosophy that instrumentation is a process control function, and subsidiary activities are minimized. Following the same philosophy, the department has divested itself of work such as the repair and maintenance of clocks, office machines, and other small mechanical equipment. The only work done by the department that is not strictly process control and metering is the maintenance of radio communication systems and laboratory instruments.

There is a *Metering Department* within the Instrument Department. It handles all accounting meters, providing the accounting groups with basic data on the distribution of steam, water, chlorine, ethylene, and other streams that are transferred from one operation to another. It is now handling over 300 charts a day. The metering group is responsible for checking the installation of meter runs and does all orifice calculations.

New employees are selected on the basis of interviews and tests. A comprehensive written test is given which covers elementary science and mathematics. This test has been satisfactory in screening applicants because a passing grade indicates good educational background and an interest in subjects that lead naturally into a knowledge of instrumentation. Training is on-the-job and specific, with only occasional classroom-type sessions. It is estimated that an average of 200 hours of nonproductive time must be spent to make a fully qualified instrument man. This is time spent in training in addition to regular work experience. All men are trained to do every type of work on each unit. Training is done by the engineers and supervisors. There is no regular rotation of job assignments for training purposes.

Electronic instruments have proved to be no problem. The key has been the selection of personnel with the proper background. Men with radio experience have been found to be well adapted to this work.

E. I. DU PONT, SABINE RIVER WORKS, ORANGE, TEXAS

The Sabine River Works of du Pont at Orange is a major unit of the chemical industry. "Alathon" polythene resin (a polymer of ethylene), methanol, and nylon intermediates are the principal products. The Instrument Division of this plant (Fig. 3) is the largest in the entire du Pont organization.

The Instrument Superintendent reports directly to the office of the Mechanical Superintendent. The total personnel is about 115. In addition to a clerk and a technician, two assistant superintendents report to the Instrument Superintendent. One of these is responsible for the instrument engineering and the other for maintenance.

The *Instrument Engineering Group* consists of seven Instrument Engineers, a clerk, and one draftsman. The engineers are given area assignments and rotate from time to time with the supervisors who report to the Assistant Superintendent, Maintenance. These supervisors are either non-technical personnel promoted from the foreman group, or graduate engineers who serve alternately in the Engineering Group or in the supervisory positions. Instrument Engineers are responsible for the selection and application of new instruments and new instrumentation installations. They follow new work in their own operating areas on a project basis from initial design through construction to start-up. They work closely with foremen in the maintenance organization, assisting them in a staff capacity with special problems. This organization and that of the Shell Oil Company in Deer Park are somewhat similar in instrument engineering organization and the responsibilities of the engineers for design, installation, and assisting the maintenance foreman.

The *Maintenance organization* is headed by an Assistant Superintendent, under whom are the three supervisors and eight foremen. The total mechanical force of 90 men is divided among these foremen. One of the foremen is responsible for the shop; the others have area assignments. The mechanics rotate on various assignments, including the shop. The technician, who reports to the Assistant Superintendent (Maintenance) is responsible for inventories, records, equipment transfers, etc. The clerk has the task of stamping about one thousand charts a day.

New men entering the Mechanical Group are selected on

Continued on page 1130

Gas-pressure Regulation

Gas pressure regulation makes use of the following types of valves, diaphragms, and loading. Practical selection factors are included.

By W. L. MASHETER
Southern Counties Gas Co. of Calif.

CONTROL of pressure in a gas piping system is necessary for safety, economy, and efficiency. The high pressures usually used for transmitting gas must be reduced before gas can be distributed safely. Excessive pressures in distribution systems contribute to a high leakage-loss because leakage in underground piping is in proportion to the gage pressure of the gas. For efficient utilization of the gas, the gage pressure at the burner orifice must be maintained within close limits.

Pressure at the control point may vary because of change in demand, change in inlet pressure, or both. The pressure is controlled by varying the opening of a valve in the gas stream. The gas regulator does this automatically. The usual method is to pipe the pressure to be controlled to one side of a movable diaphragm which is opposed by a dead weight, spring tension, or fluid pressure acting on the other side of the diaphragm (Fig. 1). The diaphragm is linked to the valve mechanism so that diaphragm movement opens or closes the valve.

There are two basic types of gas regulators—the single-seat valve, or single valve, and the balanced valve. A variation of the balanced-valve type is the unbalanced two-valve type, which has one valve slightly smaller than the other for convenience in construction; the difference in size usually is so slight that for practical purposes the regulator may be considered a balanced type.

Single-valve Regulators

Fig. 1 shows a simple single-valve regulator which is weight loaded. The principal limitation of this type of regulator is that changes in inlet pressure affect the regulated outlet pressure. For example, let us consider a weight-loaded regulator with an effective diaphragm area of 100 square inches, a valve area of 1 square inch, outlet pressure of 1.0 psig., and an inlet pressure of 11.0 psig. The 1.0-psig. downstream pressure exerts a 100-pound force upward on the diaphragm. The difference in pressure of 10 psi. across the 1-square-inch valve causes 10 pounds of additional force to be exerted upward. Therefore, as the total upward force is 110 pounds, 110 pounds in weight are required to maintain the 1.0-psig. outlet pressure. However, if the inlet pressure is increased to 21 psig., the net upward force on the valve is 20 pounds. Subtracting this from the 110-pound weight gives a resultant force of 90 pounds on the diaphragm. Dividing by the 100-square-inch effective area gives 0.9-psig. downstream pressure. Therefore, increasing the inlet pressure from 11 to 21 psig. causes a decrease in outlet pressure of 0.1 psi.

To obtain good pressure regulation with a single-valve regulator, the valve area must be smaller than the diaphragm area. The diaphragm often is linked to the valve by a lever arm to multiply the force exerted by the diaphragm. Regulators with valve diameter of from 3/16 to ½ inch and with the valve connected through a lever arm to a diaphragm with a diameter of 6 to 8 inches are commonly used for controlling outlet pressures of from 6 to 14 inches water column to individual household consumers. These regulators are usually spring loaded; occasionally they are weight loaded.

Balanced-valve Regulators

The word "balanced" refers to the effect of the differential pressure on valve position. Theoretically it is zero—that is, at any differential pressure the valve may be freely moved up and down entirely unaffected by variations in pressure. Actually, this condition does not exist because other than static forces must be considered, but for all practical purposes the valve is perfectly balanced.

This balancing is achieved by having two poppet valves of the same area on a common stem (Fig. 2). The pressure differential across the valve tends to close the upper valve and open the lower valve. As the area of the two valves is the same, the force trying to open the valve assembly is equal to and cancels out the force trying to close it. Hence the valve is balanced.

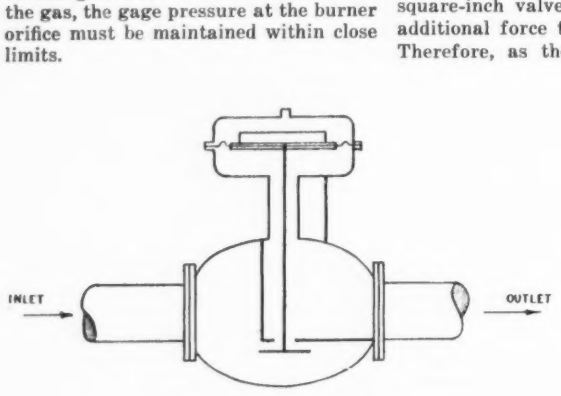


Fig. 1. Single-valve regulator.

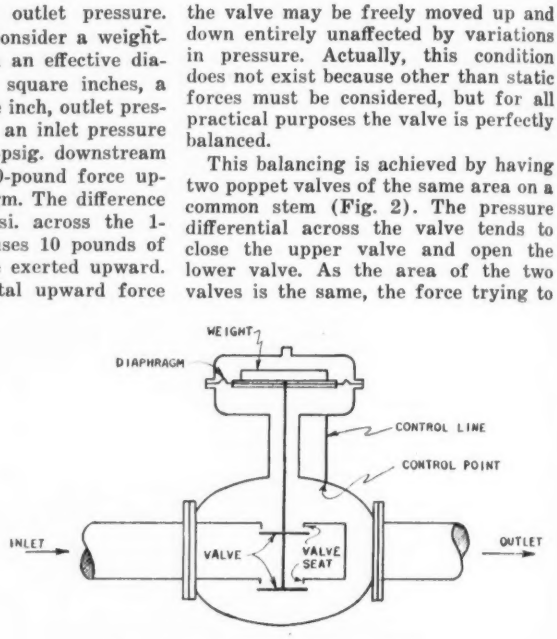


Fig. 2. Simple balanced-valve regulator.

Valve Materials

Valves and valve seats are made of a variety of materials, depending on the characteristics of the fluid regulated, the pressure drop across the valve, and the degree of shut off or "lock-up" required. If the fluid is a corrosive gas or liquid, the valve assembly must be made of corrosion-resistant material. If the pressure differential is very high, the material must be something that will withstand high velocity. If absolute shut-off is required, disks of softer material are required than would be necessary if the regulator acts simply as a throttling device and is never called upon to shut off tightly. Among the materials used for valve ports are iron, alloys of steel, and alloys of copper. Among the materials used for disks (seating surface) of the movable inner valve are leather, rubber, synthetic rubber, lead, alloys of copper (bronze), and alloys of steel (stainless steel). When pressure differentials are high, it is common practice to face both the valve ports and inner valves with chromium or stellite. When metal valves are used, they are made tight by grinding the valves to the seat.

* Presented at the Los Angeles Harbor Junior College "Instrument Maintenance Short Course," Nov. 14, 1951.

Regulator Diaphragms

The regulator diaphragm, sometimes called the "responsive element," is a device that controls the position of the regulator valve. The diaphragm size and the diaphragm material used depend on the differential pressure that exists across the diaphragm and the degree of accuracy required in the control pressure. A sensitive diaphragm (one giving close control of delivery pressure) is made of light, pliable material and has large area. This type of diaphragm, although sensitive to low pressure changes, is incapable of withstanding a high differential across it. Fortunately, where high differentials exist across a diaphragm, extremely narrow control limits usually are not required and a smaller, less pliable, and stronger diaphragm can be used.

Ordinarily, diaphragms in low-pressure regulators (delivery pressure less than 1 psig.) are of leather or thin-rubber reinforced with cloth fabric.

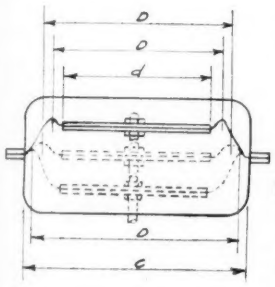


Fig. 3. (Top) Change in effective area of diaphragm with position.

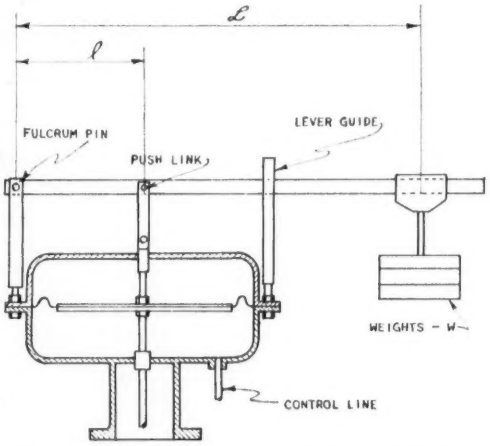


Fig. 4. (Right) Lever-weight-loaded diaphragm.

Diaphragms for high-pressure regulators (delivery pressure 1 psig. and over) are usually rubber reinforced by one or more ply of cloth fabric, depending on the pressure which will be exerted across them.

Effective Area of Diaphragm

A point of interest is the change of effective diaphragm area as the diaphragm moves through its stroke. Effective diaphragm area (D) is the area which, when multiplied by the differential pressure across the diaphragm, gives the total force exerted on the stem by the diaphragm. When the diaphragm is in the center of the case (Fig. 3), D is equal to $(C+d)/2$, where C is the inside diameter of the case and d the outside diameter of the diaphragm clamping plates. The force working over the area of D tries to raise the diaphragm stem while the force working on the area outside D is resisted by the case flange. When the diaphragm moves above the center, D is decreased; and as the diaphragm moves below the center, D is increased. Therefore, as the diaphragm moves downward, less pressure per unit area is required to balance the force of the weight in a weight-loaded regulator because the pressure is applied to a larger area of diaphragm. This increase in area of diaphragm contributes to the characteristic of direct weight-loaded, lever-arm weight-loaded, and spring-loaded regulators, which show a marked decrease in outlet pressure as increased valve opening is required of them.

Diaphragm Loading

The "load" on a diaphragm is the force acting on one side of the diaphragm and trying to open the valve. Opposing this load is the delivery pressure of a regulator, or the control pressure acting on the opposite side of the diaphragm and trying to close the valve. When the forces trying to close the valve are less than the loading forces, the valve opens. When the forces trying to close the valve are greater than the loading forces, the valve closes. Methods of diaphragm loading are (1) direct, or simple weight loading, (2) multiplied, or lever weight loading, (3) spring loading, and (4) pressure loading.

Fig. 2 illustrates direct weight loading. This is the best form of weight loading because the force remains the same and is exerted vertically on the diaphragm stem at all positions of the diaphragm. The stem of the diaphragm commonly is extended above the diaphragm through a hole in the case and the weights applied externally. This method has the advantage that the pressure can be changed easily by adding or removing weights. Direct weight loading is used mainly for low-pressure regulators because, for high delivery pressure, the weight required becomes too large.

Lever Weight Loading

Fig. 4 illustrates a lever-weight-loaded diaphragm. Mechanical leverage is used. This is used where the weight required with direct weight loading is unreasonably high. Disadvantages are (1) friction at the fulcrum pin, the lever guide, and the push link, and (2) the load is not always acting vertically on the diaphragm stem because the load moves in an arc; this sets up another friction point.

Spring Loading

Spring loading is used almost exclusively in service regulators for controlling pressure to household consumers. The advantages of spring loading are (1) light weight, (2) pressure adjustment easily made, (3) regulator and loading device are one compact unit, and (4) regulator operates in any position.

The disadvantage to spring loading is that as the diaphragm moves down, the spring extends and exerts a lesser load on the diaphragm. Therefore, the spring-loaded regulator has a greater pressure drop with increased load than the same regulator with direct weight loading.

Pressure Loading

The simplest type of pressure loading is to use a small spring-loaded regulator (pilot regulator) to maintain a constant loading-pressure on the diaphragm. This type of loading requires a constant bleed, usually in the form of a fixed orifice or adjustable needle valve. The controlled outlet-pressure from the regulator is the same as the pressure applied by the pilot regulator to the upper part of the diaphragm. An increase in outlet pressure moves the diaphragm upward, compressing the gas in the upper diaphragm chamber. This increased pressure above the diaphragm shuts off the pilot regulator and the excess loading pressure is bled off through the orifice or needle valve.

The advantage of pilot loading is that the load is exerted over the entire diaphragm area and acts in a straight line parallel to, and at the center of, the diaphragm stem, thus reducing friction. Another advantage is that the differential across the diaphragm is small and a flexible diaphragm may be used for relatively high delivery pressure.

There are numerous other types of pressure loading, many of which incorporate means by which the loading pressure is varied by controlling the discharge pressure of the pilot regulator by the outlet pressure of the main regulator. This compensates for any factors in the main regulator tending to cause the outlet pressure to deviate from the desired amount.

Diaphragm Control Valves

The term "regulator" includes the direct application under the diaphragm of the pressure to be controlled. However, when pressure regulation is accomplished by pilots which are controlled by discharge pressure, the discharge pressure need not be applied to the opposite side of the diaphragm. As a force is required to oppose the loading pressure, a spring is usually used. Such equipment usually is called a *diaphragm control valve*, or *motor valve*, and becomes a *regulator* only when complete with its pilot loading device.

Continued on page 1149

INSTRUMENT ELECTRONICS

Basic circuits for shaping waves and signals include the modulator, demodulator, limiter, clamper, gater counter, and phase shifter. Modulators and demodulators for amplitude, frequency, phase, and pulse-time modulation were discussed last month. Limiters, clampers, gaters, counters, and phase shifters are discussed in this installment.

By MILTON H. ARONSON
Technical Editor, *Instruments*

XI. SIGNAL-SHAPING CIRCUITS (Part 2)

Limiters

A limiter, or clipper, removes one extremity or the other of a wave. Limiters are used to change sine waves into square waves, to pass either positive or negative portions of a wave, to maintain waves at constant amplitude, and to protect delicate devices from excessive signals. Both diodes and amplifier tubes can be used as limiters.

Diode Limiters

A diode in series or in parallel with a signal passes only one polarity, thus clipping or limiting the signal. Fig. 11-9,A shows a series diode for clipping negative portions of a signal. The input is the dotted line; the output is the solid line. Reversing the diode results in clipping positive portions of the signal.

Fig. 11-9,B shows a *parallel-diode limiter* for limiting positive portions of a signal. Reversing the diode causes negative limiting. The finite plate resistance of the diodes in A and B causes a slight plate voltage (e_p), which is a loss in transmitted signal. Note that series and parallel limiters produce e_p losses on different portions of the cycle. This is because the series limiter limits when nonconducting; the parallel limiter limits when conducting.

It is possible to limit amplitude extremities at any level by using d-c. voltages to bias diode limiters. For example, Fig. 11-10 shows two parallel-diode limiters, each biased to different voltages, E_1 and E_2. Neither diode can conduct and limit the input until the reference voltage (E_1 or E_2) is exceeded by the signal.

Grid and Cut-off Limiting

An amplifier tube can limit positive peaks, negative peaks, or both peaks of an incoming wave. Fig. 11-11 shows an unbiased amplifier with a low-voltage B supply. When positive signals reach the grid, the grid draws electrons and biases itself negative so that it remains at cathode potential—that is, with no bias. There is little increase in plate current and hence positive limiting results.

Cut-off limiting occurs when the negative signal cuts off the plate current, thus making the tube insensitive to larger negative signals. When a low B voltage is used, the tube can be cut off by a small negative signal, thus producing cut-off limiting. The amplifier in Fig. 11-11 produces both grid limiting and cut-off limiting.

The grid resistor is used primarily to protect the source of signal from the grid current. If the source has a low impedance, the resistor may be omitted because the grid current will not affect the source voltage. Note that a small positive signal causes saturation plate current to flow, making the tube insensitive to larger positive signals. This type limiting is called *saturation limiting*.

A tube which uses both saturation limiting and cut-off limiting often is called an *overdriven amplifier*—that is, one whose grid signal is so large that it causes saturation limiting on positive peaks and cut-off limiting on negative peaks. Overdriven amplifiers are used to convert sine waves into square waves, as shown in Fig. 11-11. Note also that any amplifier tube becomes an overdriven amplifier if the grid signal is large enough.

ANSWERS TO QUIZ XI.—SIGNAL-SHAPING CIRCUITS

11-1.	(d)	11-4.	(c)	11-7.	(a)	11-10.	(c)
11-2.	(c)	11-5.	(d)	11-8.	(a)	11-11.	(c)
11-3.	(d)	11-6.	(a)	11-9.	(b)	11-12.	(c)

Test items for XI (Part 2)—Page 1163

Clamping Circuits

A clamping circuit holds a signal at a desired reference potential. It is usually a diode that is biased to the desired reference level.

Fig. 11-12 shows a diode that clamps any applied signal to ground potential and permits only variations above ground potential. For example, if a square wave that varies from +50 to −50 volts is applied to the circuit, the diode conducts when the input is less than ground potential and charges capacitor C positive to keep the output at ground potential. Thus the output changes from 0 to +100 volts when the input changes from −50 to +50. No matter what the reference level of the incoming signal, the clamping circuit puts the bottom end of the signal at zero potential (or at any desired potential).

Clamping is used extensively in sweep circuits of cathode-ray oscilloscopes because the sweep voltage must always start at the same reference point if the traces are to start at the same point on the screen. Fig. 11-13 shows a clamping diode in the sweep circuit of an oscilloscope with mag-

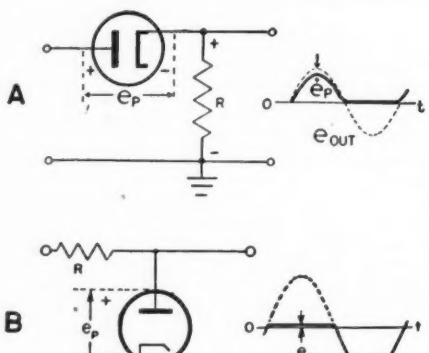


Fig. 11-9. Diode clippers. A, series diode for negative clipping; B, parallel diode for positive clipping.

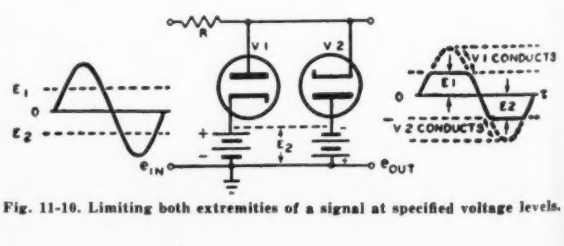


Fig. 11-10. Limiting both extremities of a signal at specified voltage levels.

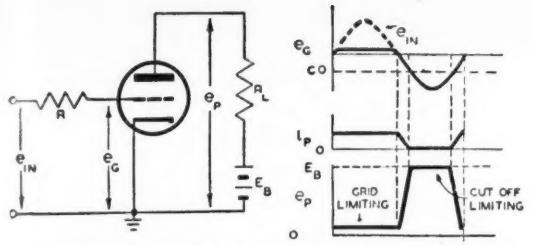


Fig. 11-11. Unbiased amplifier used for limiting positive extremities of a wave by grid limiting and negative extremities by cut-off limiting.

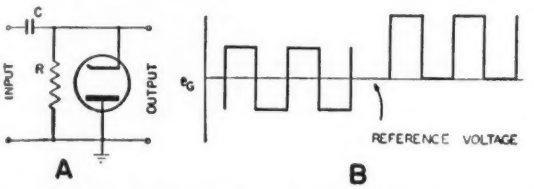


Fig. 11-12. Positive clamping. A Circuit; B operation when a square wave is applied to input.

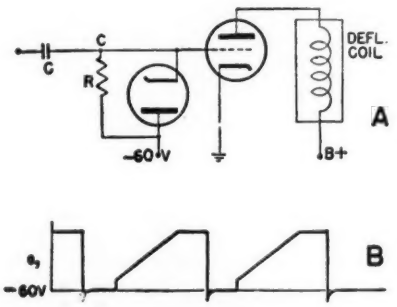


Fig. 11-13. Clamping circuit which starts each sweep waveform in a magnetic-deflection oscilloscope at —60 volts. A, circuit; B, sweep waveform.

netic deflection. The clamping diode starts the negative extreme of each sweep at −60 volts. Thus each sweep starts at the same point on the screen.

Peaking Circuits

It often is desired to produce sharp pulses with steep sides, or a narrow peaked pulse. The choice of peaking circuits depends on the kind of signal that is to be converted into the peaked pulse.

If the input signal is a rectangular or square wave, as from a multivibrator or overdriven amplifier, a simple differentiator produces sharp peaks on the fast rises and returns of the signal. This action was described in Chapter 4 (see Figs. 4-6, 4-7, and 4-8), which explained that the *R-C* differentiator can peak any nonsinoidal waveform Owing to its simplicity, the *R-C* differentiator is the most common peaking circuit.

If the input signal is a sine wave, the sine wave can be converted into a square wave by an overdriven amplifier and then peaked by the *R-C* differentiator.

One type of peaking circuit uses a saturable reactor to produce sharp pulses of high power. An applied sine wave causes saturation at one point on the wave, at which point the reactor becomes a low resistance, permitting a high-current pulse of energy to flow through the reactor. This type peaker is used in some radars.

Switching Circuits

The rapid action of both gas and vacuum tubes makes them useful as electronic switches for controlling and timing electronic circuits; electronic switching is much more rapid than mechanical switching.

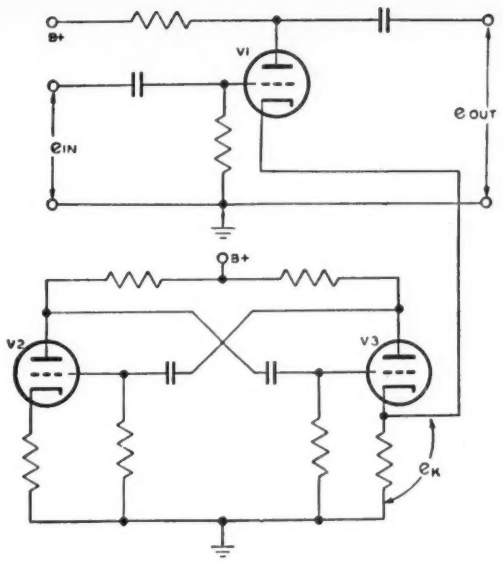


Fig. 11-14. Multivibrator gating an amplifier.

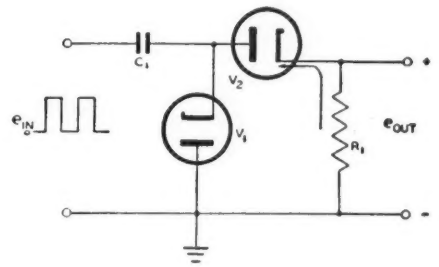


Fig. 11-15. Counting circuit.

The most common switching circuit is the multivibrator (described in Chapter 10), which is commonly called the *electronic switch*. The multivibrator is particularly useful as a switch because it develops a rectangular waveform that is immediately useful as a gate voltage—that is, as a voltage that turns circuits on and off at definite intervals.

Fig. 11-14 shows a multivibrator used to gate an amplifier tube. The cathode potential of the gate tube (V3) is a rectangular voltage that varies from ground to some positive potential each time the multivibrator cycles. When the cathode potential is at ground potential, the amplifier (V1) can operate; however, when the cathode swings positive it cuts off the amplifier tube. Thus the amplifier is *gated* at intervals. Gating circuits are used in many instruments involving timing and counting, such as radars and computers.

Counting Circuits

A counting circuit is one which produces a voltage proportional to the number of pulses it receives. There are two types— frequency and step-by-step.

A *frequency-type* counting circuit for positive pulses is shown in Fig. 11-15. Diode V2 conducts for the duration of each positive pulse. If each incoming pulse has the same amplitude and duration, the *average* current through R_1 (and hence the average output voltage) depends on the number of pulses per second—that is, on the pulse frequency.

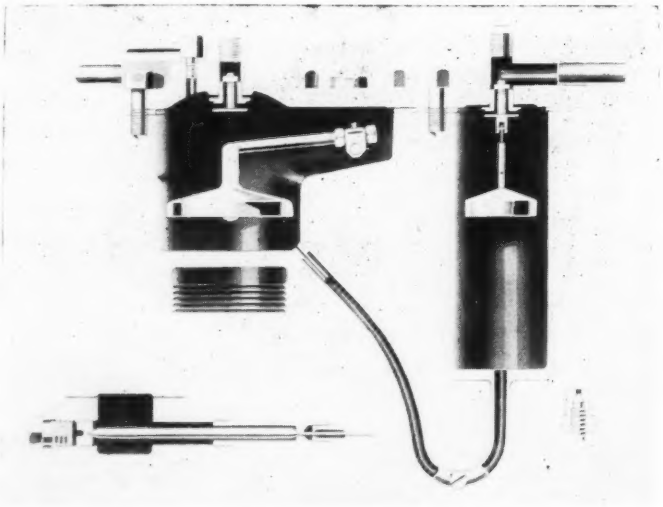
When diode V2 conducts. it charges the right plate of capacitor C1 to a negative potential. At the end of the incoming pulse, this negative potential is discharged to

Continued on page 1162

Maintenance of Pressure Recorders

By R. FRANK FIELDS, Southern California Gas Company

This article presents the installation, routine maintenance, calibration, and reconditioning technique for recorders of differential and static pressure.



Wescott 50-in. meter

ORDINARY differential orifice meters are composed of two units, one measuring the difference in pressure between the upstream and the downstream sides of an orifice plate, the other measuring the line or static pressure.

The Differential Unit

The differential portion consists of two cast-iron or steel chambers connected by a U tube. These chambers and the tube are filled to a predetermined level with clean mercury. A float in one of the chambers rests on the surface of the mercury. From this float an arm extends to a shaft that rotates with the rise and fall of the mercury. This shaft extends through the cast body of the chamber containing the float assembly, through a stuffing box which seals the pressure within the chamber. The pen arm is mounted on the other end of this shaft inside the recording case. As the rise and fall of the mercury in only one of the chambers is measured, the ratio of diameters of the chambers must be constant. This circumstance also makes it necessary that the inside diameter of these pots be true throughout their complete measuring range.

The greatest trouble encountered in the U-gage portion of this instrument is caused by the accumulation of dirt or condensate in the mercury chambers. Corrosion of the moving parts causes them to bind or wear, allowing lost motion to develop. It is necessary to keep the stuffing box well lubricated.

Calibration

It is advisable to set up periodic calibration to check accuracy and to determine when repairs are needed. This is accomplished by connecting one side of a water manometer to the high-pressure side of the instrument, leaving the low-pressure side open to air. Pressure is then applied in easy stages through an aspirator or compressed-air source to the high side of the instrument and the water column until the pen records several differential units. Pressure is then slowly released and pen action observed. If the pen falls slightly below zero, comes back above zero, and then settles on zero, the gage is free of any friction. The operator can then begin a calibration check on the meter. Pressure is again applied to the high side and the pen record is compared with the height of water in the manometer. This procedure is repeated, securing a graduation of readings until the full range of the instrument is reached. Pressure then is released slowly with the operator making the same comparisons of the pen and water column on the downward travel of the pen. If readings are identical, the recorder is in excellent condition. If the gage reads consistently higher than the manometer, the gage is fast. This condition can be remedied by lengthening the float arm to the shaft inside the chamber. If the gage readings are less than the manometer, the gage is slow and can be speeded up by shortening the length of the float arm.

If the readings taken while going upward on the chart do not correspond to those on the way down, the mercury may be contaminated, there may be condensate in the chambers, or lost motion due to worn parts or friction may exist. Rust or dirt in the chambers or on parts can cause such friction. A leak in the differential pen-arm-shaft stuffing box can produce erratic readings.

If the gage and manometer check in the lower range, are out of calibration in the middle range, but calibrate properly in the high range, a bent differential shaft is indicated. If any one or more of these troubles is found during the inspection, the meter should be reconditioned completely. *If previous records show satisfactory calibration, the adjustment block should not be disturbed.*

Reconditioning

In reconditioning the instrument, the cover plates of both high- and low-pressure chambers are removed. All mercury is drained and all parts removed. These are sight checked for undue wear, with care taken not to bend the shaft or to disturb the adjustment block. The chambers and parts should be wire brushed and washed in carbon tetrachloride or white gasoline. All rust should be removed from the U tube connecting the two chambers. Many of the newer gages are rust proofed. This makes reconditioning a simple matter of washing and cleaning.

Before assembling, lay the differential pen-arm shaft on a table top or on the glass of the meter door and roll back and forth to determine if the shaft is straight. In preparing the parts for reassembly, use a fine grinding compound to smooth up the shaft and the bearings. Use a small quantity of compound on each end of the shaft, adjust the stuffing box until there is a slight bind, adjust bearings to eliminate end play, take one wrap around the shaft with a flat string, and rotate the shaft with a pull on either end. This forms a smooth seat, free of friction or bind. These parts are removed again, thoroughly cleaned, and reassembled.

Other units are then added, with care taken to have no bind in the float pin. The float should hang evenly in the center of the chamber for true calibration. Before anchoring the adjustment block to the shaft and mounting the pen arm to the end of the shaft, the

Continued on page 1161

Presented at the Los Angeles Harbor Junior College "Instrument Maintenance Short Course," Nov. 15-17, 1951.

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CONTENTS

The Manager's Page 1092

Preconference Clinic Plans Completed 1093

Employment Service 1094

Sections Data 1095

Instrumentation for a Precision Creep-testing Laboratory 1096
by Joe Lundholm, Jr.

A Review of the Electric Displacement Gages Used in Railroad Car Testing 1101
by William Kneen

Tentative Technical Program 1106
ISA Seventh National Conference

THE MANAGER'S PAGE

Percy V. Jones, Jr.

FOR the past several months we have been calling attention to the fact that the Seventh National Instrument Conference and Exhibit will be the greatest in ISA history. We have been giving the material to you piecemeal as the information has been received. Now the complete picture is available showing the size, scope, and quality of the Conference and Exhibit. It exceeds our wildest expectations.

In order to truly appreciate the Conference and Exhibit and to gain the fullest advantage from your ISA membership, it is imperative that you attend the Seventh National Instrument Conference in Cleveland, Ohio, September 8-12. Your attendance will be of incalculable value to both you and your company as those who have attended previous meetings will attest.

We hope you have made your reservations at one of the 20 hotels in Cleveland. If you have not already done so, please take care of this today. The list of available hotels will be found both in your copy of the Advance Program which you have received and in the March 1952 issue of the ISA Journal.

To show the variety and magnitude of the Conference we are giving you an outline of the program to date.

We realize that our reporting on the Conference and Exhibit has occupied much space, which is to be expected as this is the largest single ISA activity. However, we wish to emphasize that the work of other committees has been going forward at an accelerated pace.

Instrument Exhibit Complete Sellout

The Seventh National Instrument Exhibit of ISA, the largest to date, is a complete sellout. Commercial exhibitors, realizing the advantages of displaying their products, bought booths well in advance and a great many increased their display footage.

Latest instruments and devices for measurement, inspection, testing, and automatic control will be displayed by exhibitors in 273 booths. This huge exhibit will be of great interest to the more than 10,000 engineers who plan to attend the Cleveland Conference and Exhibit.

Automatic Control

The September issue of Scientific American will be devoted to Automatic Control. This issue will be of interest to ISA members as a document helping to explain automatic control to other men in technical management with whom they must work in industry.

More RP's Coming

Vice President Boyd reported at the Executive Board meeting that Members could expect to receive five more Tentative Recommended Practices RP 7.1, RP 1.2, RP 1.3, RP 1.4, and RP 1.5 later this year.

ISA Affiliated with NRC

The National Research Council in an action of April 16, 1952 approved the Instrument Society of America as an affiliate. The ISA Executive Board in its meeting of July 18 passed a resolution accepting this invitation to become an affiliate of that council. A member of ISA will serve on the National Research Council.

Welcome Lake Charles!

The charter application of the new ISA Section, located at Lake Charles, Louisiana, was unanimously approved by the ISA Executive Board at the meeting held July 18 in Chicago. This charter is the sixth to be granted by the Board since the last annual meeting of the Society.

This section, located in a petroleum refining and chemicals manufacturing center of Louisiana, is known as Lake Charles Section. The charter membership of this group consists of six transfers and twelve new ISA members. The Secretary is Bane H. Cook, 1505 9th Street, Lake Charles, La.

We extend our heartiest good wishes to Lake Charles Section for a future of growing activity and value to its membership and the Society.

National Committees and Chairmen

Society Structure & Planning—Nelson Gildersleeve.
Nominating—G. F. Akins
Constitution, Rules & Procedures—R. L. Galley
Instrument Industry—Charles L. Saunders
Finance—J. T. Vollbrecht
Meetings and Exhibits—E. J. Grace, Jr.
Publications—C. W. Covey
Sections and Membership—M. D. Shriver
Employment—P. V. Jones
Intersociety Relations—Everett S. Lee
Public Relations—Douglas M. Considine
Government Relations—Ralph L. Goetzenberger
Educational Committee—Prof. Robert J. Jeffries
Historical—L. M. Susany
***Technical Program**
Research and Development
Instrument Operation & Maintenance
J. Johnston, Jr.
Testing Instrumentation—D. C. Little
Analysis Instrumentation—Axel H. Peterson
Instrumentation for Inspection & Gaging
W. A. MacCrehan
Instrumentation for Production Processes
W. H. Brand
Instrumentation for Transportation
F. H. Catlin
Medical Instrumentation—Dr. H. J. Morowitz
Meteorological Instrumentation
Christos Harmantas
Radiation Instrumentation—Richard W. Johnston
Geophysical Instrumentation—Dr. David Muzzey
***Physical Properties Measurement**
Aeronautic Instrumentation—Robert Tozier
Recommended Practices—A. V. Novak

**Chairman not assigned*

SPECIAL ANNOUNCEMENT

Forms for ordering the 1952 Proceedings will be provided at the Cleveland Conference.

The Executive Board has directed that the Proceedings be published as soon after the 1952 Conference and Exhibit as possible.

Be sure and place your order at the ISA Desk located in the Cleveland Auditorium.

Membership Brochure

Douglas M. Considine, Chairman of the Public Relations Committee, submitted to the Executive Board a dummy for a very attractive brochure to be used in promoting ISA membership. This brochure will be available at the Cleveland Conference and Exhibit.

I.S.A. EMPLOYMENT REGISTER

Seventh Annual Instrument Conference and Exhibit. Public Auditorium, Cleveland, Ohio, September 8-12, 1952

Seeking A Position In Instrumentation?

Registration forms and further instructions may be obtained from the Society Office. Registration by applicants may be made by mail to this office prior to opening of the Conference and Exhibit or may be made in person Sept. 8-12 at the Employment Register Desk, Cleveland Public Auditorium. You do not have to be present. Prospective employers may examine applications and make selection for mail or personal contact. **Write now for application card.**

Do You Need An Instrument Man?

Companies or institutions seeking instrument men are requested to file notice of open positions with the Society Office prior to the week of the Conference and Exhibit. These positions will be posted on the bulletin board. You do not have to be present. Interested applicants will be instructed to write direct to you.

Instrument Society of America, 1319 Allegheny Avenue, Pittsburgh 33, Pa.

BUSINESS MEETING

The Annual Business meeting of the Instrument Society of America will be held at 1:30 P.M. Wednesday, September 10, immediately after the ISA Luncheon in the Cleveland Auditorium.

All ISA members and guests are urged to attend this important meeting at which time the officers will report to the membership.

ISA Charters will be presented to the six new Sections which have joined the Society during the past year.

ISA Certificates

Many members have expressed an interest in obtaining an ISA Membership Certificate. The Executive Board has asked M. S. Jacobs, Acting Chairman of the Sections and Membership Committee, to submit a draft of such a certificate which may be purchased by members.

Six New Charters To Be Presented

The Sections and Membership Committee has been very active this year. Six new Section charters will be presented at the ISA Annual Meeting to be held in the Public Auditorium, Cleveland, Ohio, Wednesday, September 10.

Acting Chairman, M. S. Jacobs, is extremely anxious to have more men serve on this committee in view of the information received from groups all over the United States who are interested in forming new ISA Sections.

If you are interested or know of any men willing to serve on this committee, please write to Mr. Jacobs in care of ISA National Headquarters.

C. L. Clark

It is with deep regret that the Detroit Chapter announces the recent death of one of its members, C. L. Clark. Mr. Clark was employed by the Wheelco Company and joined the Detroit Chapter December 1946.

ISA Social Plans Changed

The Entertainment Committee of the Cleveland Host Committee advises that plans have been changed for the big ISA party scheduled for Wednesday evening, September 10.

This function will be held in the Public Auditorium instead of the Hollenden Hotel as previously announced.

A gala evening is planned. Free beer and pop will be served. Members and their guests will enjoy an outstanding array of eye-opening entertainment and ballroom dancing to a fine orchestra.

Handsome prizes, one of which is a television set donated as a door prize by genial Fred Lennon, Chairman of the Cleveland Host Committee, will be given away.

Price of admission is $3 for the men and $2 for the ladies.

We are looking forward to seeing you at the party.

Instrument Maintenance and Operation Committee Completes 4th Preconference Clinic Plans

The ISA Maintenance and Operation Committee and the Maintenance Clinic subcommittee of the Cleveland Host Committee have successfully completed arrangements for the Fourth Preconference ISA Instrument Maintenance Clinic. This clinic offers to instrument men and apprentices instruction on the general theory of various basic types of instruments.

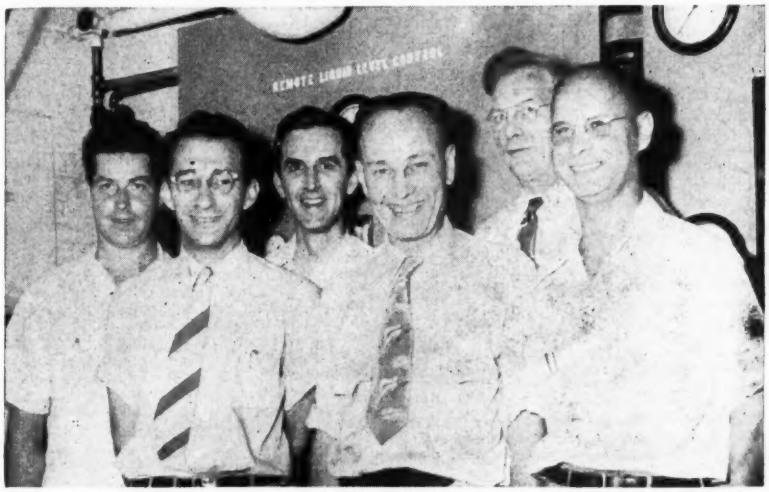
The clinic begins Friday, September 5th at 1:00 P.M. A total of nine two-hour sessions will be held; two on Friday, four on Saturday and three on Sunday. Saturday evening will be devoted to a general session on "Principles of Instrumentation and Automatic Control".

Assignment of students to classes will take place on Friday morning, September 5th, at Tomlinson Hall, Case Institute. Assignments will close at 12:00 Noon.

Actual hours of the Clinic are as follows: Friday: 1:00-3:00, 3:15-5:15, Saturday: 9:00-11:00 A.M., 1:00-3:00, 3:15-5:15, 7:30-9:30 P.M., Sunday: 9:00-11:00 A.M., 1:00-3:00, 3:15-5:15 P.M.

This Clinic is open to members of the Instrument Society of America and members of Co-operating Societies without charge. Non-members may attend to the extent of available space after registration of members. Non-members will be charged a $3.00 registration fee which must accompany application. Prior registration is required by those desiring to attend this Clinic. Registration will close on September 1st.

To register for the Maintenance Clinic, fill out the form below and mail to I. S. A. National Headquarters.



ISA MAINTENANCE AND OPERATION COMMITTEE: l to r: Bob Joyce, Standard Oil Co. (Ohio); Larry Seigel, Case Tech; John Tufft, Du Pont; Milton McMillen, Thompson Products; Dave Strong, NACA; Ralph Higgins, Diamond Magnesium. Missing when photo was taken: Frank Cochran, Lubrizol; John Kell, C&O RR.

INSTRUMENT SOCIETY OF AMERICA
1952 Pre-Conference Instrument Maintenance Clinic
Application for ADVANCE REGISTRATION
Case Institute of Technology, Cleveland, Ohio; September 5, 6, 7, 1952

Please Print the information below and return this form to
P. V. Jones, Manager ISA, 1319 Allegheny Ave., Pittsburgh 33, Pa.

NAME ..... Title or Position .....

ADDRESS .....

COMPANY ..... Products .....

COMPANY ADDRESS .....

Member of ISA? ..... Section.....

I am willing to act as group leader in taking attendance, making announcements, etc., for a group of 20 men.....

Signature ..... Date .....

NOTE: Registration FREE to members of ISA and cooperating societies; Registration Fee to all others is $3.00 which must accompany application.

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA

1319 Allegheny Ave., Pittsburgh 33, Pa.

PNEUMATIC INSTRUMENT ENGINEERS. For design and job engineering in application of pneumatic and mechanical instruments to chemical processes. Permanent position, liberal benefits. Degree in chemical, mechanical, industrial, or electrical engineering required; experience desirable. Salary commensurate with experience. Location Paducah, Kentucky. Box 674.

ELECTRONIC INSTRUMENT ENGINEERS. For design and job engineering in application of electrical and electronic instruments to chemical processes. Permanent position, liberal benefits. Degree in electrical engineering required; experience desirable. Salary commensurate with experience. Location Paducah, Kentucky. Box 675.

DEVELOPMENT ENGINEERS. For research and development in application of pneumatic and electronic controls and measuring devices to chemical processes. Permanent position, liberal benefits. Requires M. S. degree and 4 years experience in chemical, mechanical or electrical engineering, or Phd. degree and 1 year experience. Salary commensurate with experience. Location Paducah, Kentucky. Box 676.

CATALOG WRITER. College graduate or equivalent with engineering or technical background. Preferably with knowledge of industrial instruments and controls. Ability to organize material into comprehensive page formats, and to write terse, straightforward copy is important. Permanent position. Salary commensurate with qualifications. Box 677.

FIELD SERVICE ENGINEER. Industrial instruments—electrical and pneumatic. Some experience required but additional training will be furnished. Must be willing to travel. Box 678.

ENGINEERS AND PHYSICISTS. Expanding consulting instrument engineers for process, aircraft and utility industries need electronic and mechanical engineers, and physicists with industrial instrumentation experience for design of control systems and development of components. Salary and bonus commensurate with ability and experience. Box 679.

INSTRUMENTATION ENGINEERS AND MECHANICS. Repairing, making, and calibrating Industrial Instruments—on the Savannah River Project—an Atomic Materials Plant for the U. S. Atomic Energy Commission. 54 hour-week with overtime pay, housing assistance and excellent employee Industrial Relations Plan. Box 680.

TECHNICAL WRITER. Engineering degree, preferably in Physics or Electronics plus experience in writing technical reports. Salary around $90. Would work closely with scientists in the preparation of technical reports both internal and external. Box 681.

ELECTRICAL ENGINEER. (REAC Group) Degree in Electronics plus an ability to perform actual electronic work. Salary about $85. Would be required to maintain and repair the laboratory's electronic analog computer and assist in the operation of the machine. Familiarity with tubes, servos, and circuits is a must. Box 682.

ELECTRICAL ENGINEER. (Flight Instrumentation) Degree in Electronics plus about 5 years experience in circuit design or instrumentation. Salary $130. Would be responsible for the design and development of flight research instrumentation for performance data and control. A knowledge of "hardware" and an ability to work with same is required. Box 683.

MECHANICAL ENGINEER. (Development) Graduate degree in engineering plus several years experience in development. Fields of specialization might be communications, electronic circuits, dynamic systems, or instrumentation. Would participate in and be responsible for development activities in these fields. Salary to $160. Box 684.

MECHANICAL ENGINEER. (Structures) A.) Degree plus 5 years experience in the field of structures (preferably aircraft). Must be able to perform dynamic, aerodynamic, vibration work and analyze complicated indeterminate structures. Salary to $145. B.) Degree plus 5 years experience in structural and environmental testing and instrumentation. Salary about $130. Would be responsible for design, development, instrumentation, and analysis of aircraft structures. Box 685.

MECHANICAL ENGINEER. (Servomechanisms) Degree plus 5 years experience in analysis and development of servos. Salary to $130. Box 686.

INSTRUMENT ENGINEER. Position open soon for instrument man with several years experience in application and maintenance of modern instruments in paper and pulp mill. Mill located in central Pennsylvania. State experience and qualifications. Box 687.

GOVERNMENT SERVICES

To apply for any of the following Federal Agency positions, write direct to the Agency holding the position for official application form.

U. S. Naval Ordnance Test Station, Inyokern, China Lake, California

ELECTRONIC ENGINEER. Design and development of electronic instruments for use in free flight ballistic experiments on Fin-Stabilized rockets. $5060 per annum.

ELECTRONIC ENGINEER. Electronic research and development in the field of measurement. $5060 per annum.

ELECTRONIC ENGINEER. Application of new theories in the field of automatic control and instrumentation. Desire extensive knowledge of servomechanisms. $5940 per annum.

ELECTRONIC ENGINEER. Group leader for research, design, development, and operation of electronic devices for use in telemetering, Doppler, magnetic pickup, and guided missiles. $5940 per annum.

ELECTRONIC SCIENTISTS. These are project engineering positions. Experience with servomechanisms is desirable. The individuals selected must be capable of working in teams and will engage in planning and conducting tests, determining data and missile performance requirements, evaluating and assessed data, conducting liaison with contractors and preparing engineering reports on missile performance for presentation at various levels of administration in the Defense Department and private industry. $3410-$5940 per annum.

ELECTRICAL ENGINEER. Design engineer for power transmissions and distribution and detail of instrumentation facilities for ground ranges. $5060 per annum.

MECHANICAL ENGINEER. Design, develop, and service instruments and devices for precise aerodynamic and ballistic performance, measurement observation on rockets, guided missiles, and other ordnance equipment. Instruments may be mechanical, optical, electrical, or combination of all three plus electronics. $5060 or $5940 per annum.

PHYSICISTS. Theoretical design and development of specialized photographic and optical equipment and instrumentation. $5940 per annum.

PHYSICIST. Engage in personal research; supervise a program in the theoretical design and development of a wide variety of specialized photo optical equipment and instrumentation, such as ballistics, trajectory, acceleration, timing phototheodolites, and other types of cameras, comparatory precision projection equipment and stereoscopes. $7040 or $8360 per annum.

U. S. Naval Air Missile Test Center, Point Mugu, California

ELECTRONIC ENGINEER for test and development work in connection with instrumentation and electronic mechanisms used in the free-flight testing of model missiles. Must have knowledge of dynamics, electronics and some instrumentation of aircraft. $5060—$7040 per annum.

MECHANICAL ENGINEER. Experience with or desire to work with scientific instruments and measurements of physical quantities. $4205-$5060 per annum.

National Bureau of Standards, Corona Laboratories, Corona, California

ELECTRONIC ENGINEERS. These positions require experience in servomechanisms, microwave electronics, miniaturization of electronic systems. $3410-$8360 per annum. Salary will depend on qualification of applicant. Experience may be in one or more of the fields indicated.

ELECTRONIC ENGINEER. Maintaining and checking out telemetering transmitter units and ground telemeter receiving stations; assignments will be at Chincoteague, Virginia and elsewhere. $4025 per annum.

U. S. Navy Electronics Laboratory, San Diego, California

ELECTRONIC SCIENTIST. Assist in Laboratory instrumentation and integration of man-machine combinations into shipboard systems and in the experimental study and evaluation of these systems. Experience with techniques involved in radar, sonar, radio, computation, control and general electronic equipment. $5060 per annum.

ELECTRONIC SCIENTIST. Assist in the planning and study of instrumentation and integration of man-machine combinations into shipboard systems. Familiarity and experience with techniques in radar, sonar, radio computation, control, and general electronic equipment. $5940 per annum.

Just Published

Industrial Instrument Training Course Outline

Prepared by ISA Subcommittee on Instrument Mechanic Training under chairmanship of George A. Larsen.

60 pages—heavy-paper bound

Prices per copy — $ .75 to members; $1.50 to others

Instrument Society of America, National Office

1319 Allegheny Ave., Pittsburgh 33, Pa.

Section Secretaries, Meeting Data and Programs

AKRON
Russell F. Marquardt, 1782 Tonawanda Ave., Akron 5, Ohio. Tel: ST-6865
Fourth Tuesday, Meeting 8:15 P.M., U. of Akron, Ayer Hall, Rm. 212-B.

ALBUQUERQUE
W. E. Bostwick, 700 C. North Washington, Albuquerque, N. M.
First Monday, Meeting at 8:00 P.M., Mitchell Hall, Univ. of New Mexico.

ARUBA
J. L. Lopez P. O. Box 203, c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I. Tel. 2087.
First Tuesday, 7:30 P. M., Engr's Club.

ATLANTA
M. Virgil Davis, 357 Sixth St., N.W. Atlanta, Ga. Tel. EM. 3042
Fourth Friday, Meeting 7:30 P.M., Electric Bldg., Georgia Power Co.

BALTIMORE
G. B. Greer, 631 East 36th St., Baltimore 18, Md. Tel: CHesapeake 6879
Second Friday, Meeting at 8:00 P.M., Engr's. Club of Baltimore.

BATON ROUGE
G. M. McCarroll, 1813 Edinburgh Ave., Baton Rouge 6, La.
Meeting monthly, L.S.U. Physics Bldg.

BOSTON
Stephen E. Lord, 60 Braintree Ave., Quincy 69, Mass. Tel: MA 9-1066
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 7:30 P. M., 99 Club, 99 State St.

CALIFORNIA
Gerald B. Miller, 4622 Halbrent Ave., Sherman Oaks, Calif.
Second Wednesday. Dinner at 6:30 P. M. Meeting at 8:00 P. M.

CAROLINA PIEDMONT
L. Frank Lawrence, Minneapolis-Honeywell Regulator Co., 2400 Wilkinson Blvd.. Charlotte, N. C., Tel: 5-4422
Second Friday, Dinner at 7:30 P.M., Meeting at 8:30 P.M. Cardinal Restaurant, Charlotte, N. C.

CENTRAL ILLINOIS
H. R. Getz, 723 Laura Ave., Peoria 5, Ill. Tel: 4-2800
First Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M.

CENTRAL INDIANA
Norman Krone, 123 N. Grant Ave., Indianapolis, Ind. Tel: IRvington 5337
First Tuesday, Meeting at 7:30 P. M.

CENTRAL NEW YORK
H. G. Murray, 169 Durston Ave., Syracuse 6, N. Y. Tel: 9-9259
Third Monday, Dinner at 6:00 P. M., Meeting at 8:00 P. M.

CENTRAL OHIO VALLEY
J. C. Dilliner, 813 Winton Ave., Belpre, Ohio.

CHARLESTON
D. A. Cunningham, 5140 Washington Ave., S.E., Charleston, W. Va. Tel. 55403
First Monday, Dinner at 6:15 P.M., Meeting at 8:00 P.M., Kanawha Airport Terminal Bldg.

CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P.M., Hotel Shoreland.

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P.M., Michelson Lab, USNOTS, Conference Room.

CINCINNATI
E. J. Geiser, 3666 Hubble Rd., Cincinnati 24, Ohio Tel. Ja. 5618.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P.M., Engineering Soc. of Cinn.

CLEVELAND
G. D. Carnegie, 3436 Lorain Ave., Cleveland.
Second Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P.M., Cleveland Eng'r. Society, 2136 E. 19th St.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191,Ext. 247.
Third Thursday, Meeting at 8:00 P.M., Battelle Auditorium

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P.M.; Ali Ghan Shrine Country Club, Baltimore Pike.

DENVER
G. M. Peters, 3191 W. Denver Place, Denver 11, Colo. Tel: GRand 9073

DETROIT
Ralph Hoxie, Basic Service Corp., 14016 Woodrow Wilson, Detroit 6, Mich., Tel: TO-88043
Third Wednesday, Meeting 8:00 P. M., Rackham Memorial Bldg., 100 Farnsworth, Detroit, Mich.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P.M., Siena College, Loudonville, N. Y. Optional Dinner at 6:00 P.M., Circle Inn, Lathams, N. Y.

GULF COAST
Harold Placette, 2440 Neches Ave., Port Arthur, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

HOUSTON
A. Costa, 714 East 17th St., Houston 8, Texas.
Last Monday, Meeting at 8:00 P.M., University of Houston Library Building.
August 23, Annual Stag Barbecue, 2:00 P. M., Spring Branch Gun Club, Houston

KANSAS CITY
J. C. Brous, 8827 Maiden Lane, Kansas City 5, Mo. Tel: HI 8556
First Tuesday, Meeting at 7:30 P.M., U. of Kansas City, Science Bldg., Rm. 106.

LAKE CHARLES
Bane H. Cook, 1505 9th St., Lake Charles, La.

LOUISVILLE
C. M. Bosworth, 5336 Westhall Ave., Louisville, Kentucky. Tel: FR 3494
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 710 Victoria Square, Montreal, Quebec

MUSCLE SHOALS
Atherton Hastings, Tennessee Valley Authority, Div. of Chemical Engineering, Wilson Dam, Alabama. Tel: Sheffield 3160, Ext. 6238
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.

NEW ORLEANS
W. H. Haney, 2927 Music St., N. O. 22, La.
No Regular Date, Meeting at 8:00 P.M.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.

NIAGARA FRONTIER
Mrs. James L. Martin, 34 Manning Rd., Eggertsville 21, N. Y. Tel: WIndsor 0087
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., N. Y. State Inst. of Arts and Sciences, Buffalo.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHERN CALIFORNIA
Bert L. Anderson, 1951 47th Ave., San Francisco 16, Calif. Tel: SEabright 1-5030
Third Monday, Dinner 6:30 P. M., Meeting 8:00 P.M., Spengers Grotto, 1919-4th St., Berkeley.

NORTHERN INDIANA
J. Baum Beckman, 7145 Wicker Ave., Hammond, Ind. Second Tuesday, Meeting at 7:30 P.M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
George Ritscher, 113 Gorgas Lane, Oak Ridge, Tenn. Tel. 5-1084
First Wednesday, Meeting at 7:30 P.M., Ridge Recreation Hall

ONTARIO
John W. Huether. 311 Southernd Dr., Leaside. Ontario, Canada. Tel: HU-7114
Third Thursday, Meeting at 8:00 P.M. Friendship Hall, College St. United Church, Toronto

PANHANDLE
George W. Leggett, Box 1526, Phillips Chemical Co., Borger, Texas

PERMIAN BASIN
J. B. Jenkins, 509 South Ave. "C," Kermit, Texas. Tel: 3220
Second Tuesday, Meeting at 7:30 P. M., Gulf Oil Corp. Auditorium or Odessa College.

PHILADELPHIA
R. A. Trenner, Energy Control Co. Rm. 306, 3147 N. Broad St., Philadelphia 32, Pa. Tel: SA 2-7900
Third Wednesday, Meeting at 8:00 P.M., Bellevue-Stratford Hotel.
September 18, "Gadget Contest," Prizes to be awarded to local members.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 5500 Fifth Ave., Pittsburgh 13, Pa. MAflower 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel

PRESQUE ISLE
Edwin P. Schuwerk, 445½ Halley St., L. P., Erie, Pa. Tel: 2-3349
Fourth Tuesday, Meeting at 8:00 P.M., G. E. Community Center, East Lake Rd., Erie, Pa.

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash.

ROCHESTER
R. C. Schwarz, Jr., Foxboro Co., 1201 Granite Bldg., Rochester 4, N. Y. Tel: Hamilton 1468.
Fourth Tuesday, Meeting at 8:00 P.M., Univ. of Rochester, Physics Lecture Hall.

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Second Monday, 8:00 P. M., Y.M.—Y.W.C.A.

SAVANNAH RIVER
F. P. Ledford, Jr., c/o Field Project Manager Ga.,
E. I. du Pont de Nemours and Co., Box 117 Augusta, Ga.

SOUTH TEXAS
H. C. Givens, La Gloria Corp., P.O. 637, Falfurrias, Texas. Tel: 122-W
First Wednesday. Meeting at 7:30 P.M.

SOUTHERN MICHIGAN
Lyle J. Draper, 2233 Oakland Dr., Kalamazoo, Mich.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M., Chicken Charlie's, Kalamazoo.

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P.M., Engineer's Club of St. Louis.

TOLEDO
P. H. Girkins, 418 Waggoner Blvd., Toledo 12, Ohio. Tel: LA 6505
Third Tuesday, Meeting at 8:00 P. M., Service Bldg., Toledo Edison Co.

TENNESSEE
James L. Williams, 2237 Bruce St. Kingsport, Tenn. Tel: 2079-L
Fourth Thursday, Civic Auditorium.

TULSA
S. M. Bagwell, 1544 E. 35th Pl., Tulsa 5, Okla. Tel: 7-6822
First Monday, Meeting at 7:30 P.M., Engineering Bldg., Tulsa Univ.

TWIN CITIES
Jerome J. Schwab, Engineering Sales, 516 Guardian Bldg., St. Paul 1, Minn. Tel: GArfield 0601
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P.M., Rm. 353, Coffman Memorial Union, U. of Minn.

WASHINGTON
Edward C. Lloyd, 2105 Spencer Road, Silver Spring, Md. Tel: SH. 9340.
Third Monday, Meeting at 8:00 P.M., P. E. P. Co. Auditorium.

WAYNE COUNTY
Clarence Ellison, 2443 15th St., Wyandotte, Mich. Tel: Avenue 2-4178

WILMINGTON
E. Avery Taylor, Taylor Instrument Co., Industrial Trust Bldg., Rm. 510, Wilmington, Del. Tel: 9814.
Third Tuesday, Meeting at 8:00 P.M. Harlan Public School, Wilm.

Instrumentation for a Precision Creep-testing Laboratory

By JOE LUNDHOLM, JR.*

As engineers continue to design complex equipment to operate at high temperatures and high stresses, need for accurate creep testing data becomes of greater importance. Creep is defined as the time rate of deformation that occurs when metals are subjected to load or stress well below the yield point, the proportional limit, or the apparent elastic limit at high temperature.[1] A creep testing laboratory is concerned with measuring the creep rate, or the change in length versus time of a special test specimen held at a definite temperature. When one envisages the complexities of modern equipment, it is easy to see that unless the creep rate of the metal parts is known beforehand, close tolerances might disappear in a few hours operation, rendering the equipment useless.

In order to obtain accurate creep testing data, it is necessary that stable operating conditions be maintained for periods of 1000 to 10,000 hours. Furthermore, in the case of certain metals which are being investigated at the present time, it is necessary to test them in either high vacuum or inert gas atmospheres to prevent serious oxidation of the specimen.

Creep is an extremely temperature dependent phenomenon and significant variations in rate of creep can be produced by very small differences in temperature.[2] It has been stated that an increase in the temperature of 6° to 12° may double the creep rate in certain metals.[3] Furthermore, anisotropic type of crystal structures in metals may display permanent dimensional changes due to temperature cycling alone. This means that temperature control continues to be one of the main problems in the design of a creep testing laboratory.

*Oak Ridge National Laboratory, Oak Ridge, Tenn.

Presented at the Sixth Annual Conference of the Instrument Society of America, at Houston, Texas, Sept. 10-14, 1951.

Design Specifications of the Laboratory

The general design specifications of the creep testing laboratory centered around 16 testing machines, eight of which are equipped with vacuum furnaces to operate at 0.1 micron pressure or lower and at temperatures up to 1000°C; six inert gas atmosphere furnaces to operate at temperatures up to 1000°C; and two standard tube furnaces to operate up to 1000°C. Each testing machine and associated furnace has its own temperature recorder-controller with thermocouple fail-safe protection. All control and recording instruments are mounted in a central control panelboard as shown in Fig. 1.

Four thermocouples are wired to the surface of each test specimen, three of which are used for checking the temperature gradient across the test specimen, and one for the temperature controller.

In order to monitor the 64 Chromel-Alumel thermocouples, a 75-point precision indicator is used. A 12-point strip-chart temperature recorder is used to continuously monitor a selected group of the thermocouples. A special plug system is used with flexible leads to enable one to choose any 12 couples in the precision indicator to be recorded. The recorder is used mainly for checking on temperature gradients in the furnaces and to facilitate shunting the furnace if a temperature gradient exists.

Special thermocouple plug panels are installed at each testing machine to facilitate installation of the furnace assembly. They consist of four two-pole receptables mounted in a single outlet box cover. All the metal parts of the plugs and receptables are made of thermoelectric material to match that of the thermocouples being used. This tends to eliminate all sources of extraneous thermal emf's.

Small special panels were also fabricated to facilitate the installation and removal of the two vacuum thermocouple gages and the one Phillips ion gage for the vacuum system. All vacuum gages are monitored from the central control panel-board along with the control of the mechanical and VMF-80 oil diffusion pumps.

An emergency automatic starting 20-kilowatt motor-generator set is provided in case of a power failure which would ruin the tests. A power failure would not only cause a serious temperature fluctuation, but failure of the mechanical vacuum pumps could result in cracking the diffusion pump oil and also in oxidation of the test specimen.

Fig. 2 shows a view of the six inert gas atmosphere units. Fig. 3 shows the disassembled parts of the special furnace which is used for both the high vacuum and inert gas tests. It shows the bellows which allows the pull rods to move as the specimen elongates during the test, the rubber sealing glands for the thermocouples, the thermocouples wired to both a flat strip and a round test specimen, radiation shields on the pull rods, water cooled ends and windowports, and the ten taps on the furnace windings.

Specimen Temperature Measurement

The design requirements call for four thermocouples to be wired to the surface of the test specimen as shown in Fig. 3. At the present time, specially calibrated 20-gage Chromel-Alumel thermocouples are being employed.

Three of the thermocouples are for determining the temperature gradient across the length of the test specimen.

Fig. 1. View of central control panelboard.

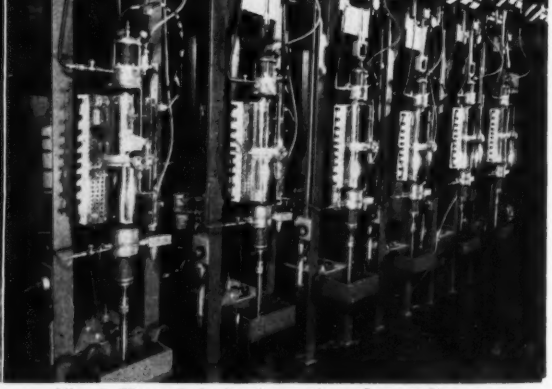


Fig. 2. View of six inert gas atmosphere units.

These thermocouples are wired on the surface at the top, middle, and bottom of the test specimen. It is desired to maintain these three temperatures within 1° C of each other. The furnaces are all specially wound with spaced windings which provide extra turns at the ends to compensate for the additional end heat losses. This materially aids in providing a uniform temperature over the entire length of the tube furnace. The furnaces are also tapped at ten points for adding external shunts which are used to provide additional control over the temperature gradient when necessary.

Since both the vacuum and inert gas atmosphere furnaces consist of a 2.5 by 0.125 inch wall stainless steel tube placed inside the Alundum tube which holds the windings, it has been found that the temperature gradient across the length of the test specimen is already well within the desired 1° C limit. This is due to the stainless steel and Alundum tube tending to even out the temperature gradients. Consequently, the external shunts are seldom needed on these furnaces.

The fourth thermocouple is also wired on the surface at the center of the test specimen and is used for control purposes only. It is connected to one of the 16 temperature recorder-controllers. This also provides continuous monitoring of the specimen temperature. Since the electric proportional controllers are equipped with automatic reset or droop correction the specimen temperature should stay at the set value for long periods of time, barring a shift in thermocouple calibration, thermocouple failure, or instrument failure.

Selection of Thermocouple

The selection of the proper type of thermocouple was given considerable thought. When the vacuum furnace was dissassembled after an initial test run with Chromel-Alumel thermocouples, all the parts showed a coating of metal. This was the result of high temperature (800° C) and high vacuum (0.1 micron) which allowed various alloy materials to literally "boil off" or vaporize out of the metal parts in the furnace, possibly including the thermocouple materials.

Subsequent tests with both Chromel and Alumel spirals in a partially enclosed quartz tube placed inside the furnace at various temperatures have shown that aluminum may vaporize from the Alumel wire at around 750° to 800° C and it appears that manganese is evaporating from the Chromel wire. In the case of Chromel the quartz tube was clear except at each end where the tube entered the cooler zone of the furnace and at that point a ring of manganese colored material was deposited. In the case of Alumel the quartz tube had a heavy plating of what was thought to be aluminum on the inside. In both cases, the amount of deposited metal was too small to obtain a definite chemical analysis of its composition.

To determine if this was affecting the calibration of the Chromel-Alumel thermocouples, tests were conducted with iron-constantan, Chromel-Alumel, and platinum, 10 per cent rhodium-platinum thermocouples wired to the surface of the specimen, and a Chromel-Alumel thermocouple placed in a stainless steel well exposed to the open atmosphere. Tests of 100 hours each at five different temperatures up to 800° C showed no definite change in calibration of any of the various thermocouples. It appears that one type of thermocouple is as good as the other.

Recent tests have shown that the alloy constituents of the stainless steel tube of the vacuum furnace itself will vaporize and coat the quartz tube without any thermoelectric materials in the furnace at temperatures above 800° C.

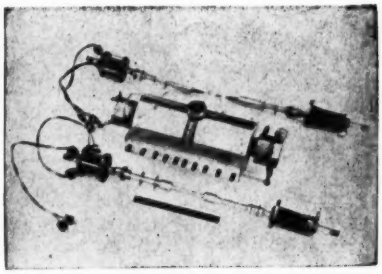


Fig. 3. Disassembled parts of vacuum or inert gas atmosphere furnace with thermocouples wired to the test specimen.

Even this does not appear to be affecting the temperature-emf properties of the thermocouples.

Chromel-Alumel Being Used

Although no shift in the calibration of the iron-constantan thermocouples was found, it appears that the manganese in the constantan and other controlled impurities in the iron wire could likewise vaporize under the test conditions. Furthermore, platinum thermocouples are notorious for their tendency to alloy with extraneous metallic vapors, thereby considerably changing their calibration. These phenomena might be particularly bad in a high-vacuum atmosphere although present tests have shown no definite shift in calibration.

Tests are being continued to see if any definite change in the calibration of the three types of thermocouples is occuring and to what degree.

At the present, Chromel-Alumel thermocouples are being used and are serving satisfactorily. Tests indicate that the variation in calibration of these couples is in the order of 2° to 3° C over long periods of time. This is a matter of a shift in the calibration and not the initial absolute accuracy.

To achieve initial absolute accuracy of the thermocouples, it is necessary to compare the calibration of the wire being used with known accuracy material. For these checks, special 8 gage Chromel-Alumel wire pairs as supplied by the National Bureau of Standards are used. This wire has a stated accuracy of plus or minus 2° C and the errors in our calibration amount to approximately one degree. Thus, the initial absolute accuracy of the Chromel-Alumel thermocouple is probably plus or minus 2.5° C for temperatures up to 1000° C.

For greater accuracy below 500° C it would be possible to calibrate the couples with a platinum resistance thermometer. This is considered unnecessary at the present time as it is felt that other errors such as the shift in calibration during long time tests are in the order of a few degrees centigrade.

Measurement of Creep Rate

At the present time, the optical method of measuring the extension of the specimen is being used. With this method, a measuring microscope with a bifilar eyepiece is employed to view specially marked platinum strips which are wired to the test specimen. In order to view the test specimen with the platinum strips, it is necessary to on diametrically opposite sides of the provide two viewing windows placed furnace. It is often desired to view two sets of strips from opposite sides of the specimen to determine if the load on the specimen is producing straight-line motion and not bending the specimen.

With this method, and the existing microscope, a sensitivity of 50 microinches is being obtained. With the three-inch long specimen, this amounts to 17 microinches per inch.

A rule of thumb is that the maximum sensitivity of the creep measuring apparatus be comparable to the magnitude of the thermal expansion effects produced by temperature variations of the specimen. This effect in many materials amounts to 10 to 20 microinches per inch per degree centigrade.

A development program is being initiated to design a recording extensometer to eliminate the necessity of having an operator spend considerable time each day to "read" the platinum strips. This is also desirable in that it would give additional information on creep phenomenon, such as momentary high rates of creep. It also would allow one to correlate sudden changes in creep rates with temperature fluctuations, and the like.

It appears that this is a rather formidable project considering the fact that both extreme sensitivity and long time stability are needed. A unit utilizing strain gages, linear differential transformers, or variable capacitance between two plates or concentric cylinders is being considered. The problem is further complicated in this case due to the necessity of either inserting the

equipment inside a cooler zone of the vacuum furnace, or transmitting the mechanical motion through bellows to the outside of the furnace. The latter method is probably impractical because of the accuracy of measurement desired.

The Problem of Temperature Control

The initial design specifications on quality of temperature control were, of course, dependent on testing available industrial controllers to determine their capabilities. Initial tests and subsequent rechecks have shown this to be in the order of plus or minus 1° C over long periods of time an instrument span of 0 to 1000° C using Chromel-Alumel thermocouples.[4]

Due to the design of the special vacuum and inert gas atmosphere furnaces, which require water-cooling of the furnace ends to protect "0" ring seals, bellows, thermocouple entrance seals, and the like, it was desired that the control thermocouple be wired directly to the surface of the test specimen rather than being placed near the windings. In any case, placing the control thermocouple on the specimen is better, since the temperature of the windings are never the same as the specimen; thus, requiring a correction factor in determining the set point. Obviously, this will necessitate the use of a proportional controller to eliminate the hunting or cycling produced by a simple "on-off" controller.

The lags to be expected in the measurement of temperature of the specimen in the vacuum were considered; especially, since the only means of transferring heat in a vacuum is by radiation. Furthermore, it was necessary to transfer the heat not only through an Alundum tube but also through a stainless steel tube which is the actual vacuum chamber. Unfortunately, stainless steel has both a high specific heat and a low thermal conductivity.

Tests showed that at temperatures above 500° C the lags were quite small, but as the control temperature approached 200° C, the lags were of great enough magnitude to approach the limits of adjustment of the controller. Specifically, the reset rate or rate of droop correction was too fast with the controllers which were used. In a few cases, it has been necessary to remove the automatic reset and adjust it manually. A general statement may be made that higher temperatures are more easily controlled due to better heat transfer and the resultant reduction in time lags in the system.

Types of Control Considered

The result of this study showed that there existed three principal types of proportional controllers equipped with automatic reset or droop correction capable of controlling electric furnaces.

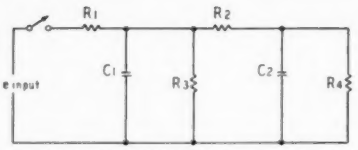


FIG 4 ELECTRICAL REPRESENTATION OF TUBE FURNACE

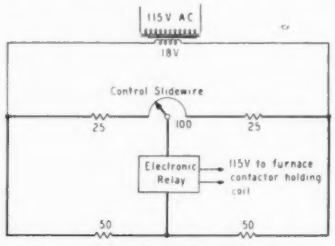


FIG 5 SIMPLE "ON-OFF" CONTROLLER

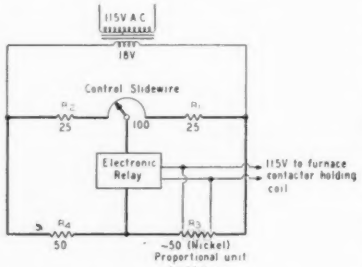


FIG 6 PROPORTIONAL "PERCENTAGE ON-TIME" TYPE CONTROLLER

These are as follows:

(1) "Percentage on-time" type, known by such names as *Duration Adjusting Type*, *Electr-o-Pulse*, *Putmo*, and so on.
(2) Electric or pneumatic actuated Variac or Powerstat unit.
(3) Saturable reactor type.

The accuracy of the temperature measurement would be identical in all cases if a similar type recorder-controller with calibrated thermocouples was used.

All three types of controllers were tested. In all cases, strip-chart recorder-controllers were used in order to achieve maximum readability of the record.

The "percentage on-time" type controller achieves control by pulsing the power to the furnace, achieving proportional control by varying the "percentage on-time". It requires only a standard power contactor or relay as the control element. It is available as a completely electric type controller. Results showed control to plus or minus 1° C with an instrument span of 0 to 1000° C.

The electric driven or pneumatic actuated Variac or Powerstat control system achieves control by adjusting the furnace input voltage to the value necessary to maintain the desired temperature. Both the electric and pneumatic system were tested and the control results obtained were identical. The cost of the electric type control unit with strip-chart recorder, control unit, electric drive unit, and Variac is practically the same as the strip-chart pneumatic controller with a commercially available pneumatic actuated Variac or Powerstat unit.

One drawback to the latter system is the step-action of the Variac or Powerstat caused by the convolutions in their windings. This control element has a minimum voltage change of 0.25 to 0.5 volt depending on the type. The second drawback is the non-linearity of the control unit when one considers the power input versus position of the Variac. This results because power is proportional to the square of the voltage. This is not a serious disadvantage but should at least be considered. While the control is almost as good as that obtained with the "percentage on-time" type, it appears to be continually cycling over at least plus or minus 1° C as the Variac hunts between adjacent convolutions. The "percentage on-time" type merely displays long time drifts of the same magnitude. Since a minimum of cycling is desired, this would tend to rule out the Variac unit in this case.

The saturable reactor unit achieves control by a varying impedance (the saturable reactor) which is placed in series with the furnace windings. The impedance of the reactor is varied by changing the magnetic saturation of the iron circuit in the reactor. By control of a few watts of d-c saturating current, a few kilowatts of a-c power can be controlled. The complete unit —consisting of the recorder-controller, electric reset or droop correction unit, Reactrol panel for supplying the d-c saturating current and the appropriate saturable reactor — is considerably more complex than the other two types of controllers. It has the disadvantage of requiring that the saturable reactor be correctly matched to the particular furnace. It is also considerably more costly. The control results obtained with the unit are comparable to that obtained with the "percentage on-time" type.

The "percentage on-time" type controller was chosen after considering the factors of quality of control, dependability, and cost. As mentioned previously, closeness of control was as good or better than the other two types. The only critical item in the control unit is one vacuum tube. Furthermore, there is no air supply problems. On a cost comparison based on the use of strip chart recorders, the Variac type is 25 per cent more costly than the "percentage on-time" type and the saturable reactor type is 50 per cent more costly.

It should be stated that there are two types of furnaces for which the "percentage on-time" type of unit is not particularly well suited. One is a very small furnace with little insulation which means that the effective time constant of the furnace is very small. This furnace cannot tolerate the

on-off periods of this type controller and one of the other types which provide continuous power input should be used. The second type of furnace is the very large type where it is not advisable to be continually loading and unloading the building distribution system which might cause trouble to other research projects. In this case, the saturable reactor type is best suited for handling these large loads.

Operation of "Percentage On-Time" Controller

The "percentage on-time" type of control unit achieves proportional control by pulsing the power to the furnace—say, 5 seconds "on" and 5 seconds "off" which is 50 per cent "on-time"; or 6 seconds "on" and 4 seconds "off" which represents 60 per cent "on-time."

A furnace can be represented in electrical terms as shown in Fig. 4 where C_1 represents the thermal mass (mass times specific heat) or capacity of the windings and the Alundum tube which holds the windings; C_2, the thermal mass of the specimen or furnace charge; R_2 the resistance to the transfer of heat to the specimen; R_3 and R_4, the heat losses through the insulation from the windings and through the ends of the furnace from the specimen.

With reference to Fig. 4, it can be seen that this represents a filter network for obtaining smooth d-c from half or full-wave rectification. It is also known as a second-order system. Furthermore, the effective time-constant of the usual furnace is such that one can tolerate on and off periods of five seconds to as much as 60 seconds without seeing a fluctuation of temperature at the specimen.

This is possible only with at least a second or higher order system. With a first order system, which would be equivalent to placing the thermocouple directly on the windings, it would be impossible to eliminate the effects of on-off action. Consequently, this system works best with the control thermocouple placed directly on the test specimen.

In order to explain the operation of this electric control unit as to how proportional action, droop correction, and impulse rate are obtained, it will best be seen by analyzing a series of three drawings.

Basic Operating Principles

With reference to Fig. 5, it is obvious that this is an ordinary Wheatstone bridge circuit, fed with an a-c source, and using an a-c detector which will only actuate the contactor if the bridge is unbalanced in the correct direction. In other words, the a-c detector is phase-sensitive. A control slidewire is used to provide the electrical signal indicating whether the temperature departure is above or below the set point and the extent of the departure. The control slidewire is attached to the same shaft as the measuring circuit slidewire. The resistors are all manganin (zero-temperature coefficient wire).

This unit will provide ordinary, non-proportional on-off control and the temperature will cycle (overshoot and undershoot) as is characteristic of any on-off controller. The main thing to notice is that if the temperature drops, the bridge is unbalanced due to the contact shifting on the control slidewire and unbalancing the bridge in the correct direction to actuate the power contactor. When the temperature reaches the correct value, and not until then, will the contactor be opened. Naturally, the stored heat in the windings will cause the temperature of the specimen to continue to rise above the desired value.

The next figure (Fig. 6) is the same bridge circuit but with resistor R_3 replaced with a nickel resistor, wound intimately with a small five-watt heater. The heater is energized whenever the power is applied to the furnace. The cooling and heating of the nickel resistor will be sufficient to unbalance and balance the Wheatstone bridge. To show how this bridge, Fig. 6, provides proportional control only, it is necessary to keep in mind the exponential heating and cooling curves (Fig. 7) of the resistor-heater assembly.

How Percentage On-Time Is Determined

Fig. 7 shows how the temperature at which R_3 operates determines the "percentage on-time". Assume that the furnace is operating with 50 per cent on-time at the set point when a drop in line voltage causes the temperature of the furnace to fall. This will cause leg R_1 of the bridge to have more resistance than R_2, unbalancing the bridge in the direction to actuate the furnace contactor.

The furnace will continue to heat until the resistor-heater unit R_3 is heated to have sufficient resistance to balance the bridge

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

To maintain this higher temperature, in R_3, a greater "percentage on-time" will be required—say, 60 per cent. By varying the proportional band adjustment which consists of a variable shunt on the control slidewire, any percentage proportional band can be obtained.

As is the case with a proportional controller, the temperature will droop or be displaced from the set point due to a sustained load change or drop in line voltage. This can be corrected by making resistor R_4 variable, thus, providing manual droop correction or reset. This may be seen by the fact that as R_4 is increased, R_3 must heat to an even higher temperature to maintain the bridge in balance. Thus, by slowing manually increasing the "percentage on-time" of the power to the furnace, the temperature will eventually be brought back to the set point.

Automatic Reset

In Fig. 8, R_4 is now also made of nickel with a five-watt heater and provides automatic droop correction. This resistor-heater assembly (R_4) is of the same physical dimension as R_3 but wound on a solid steel slug instead of a thin-walled, hollow brass tube as is R_3.

The operation of the two resistor-heater units is equivalent to the two bellows used in a pneumatic controller to achieve automatic reset, where one tends to either "chase" the other up or down to increase or decrease the value of the controlled variable.

If a line voltage change causes the temperature of the test specimen to drop, the bridge is unbalanced

$$\frac{R_1}{R_2} > 1$$

the furnace contactors is actuated, and R_3 will increase in value to balance the bridge

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

The unit will now pulse at some greater "percentage on-time". Due to the steel core, R_4 will heat very slowly but as

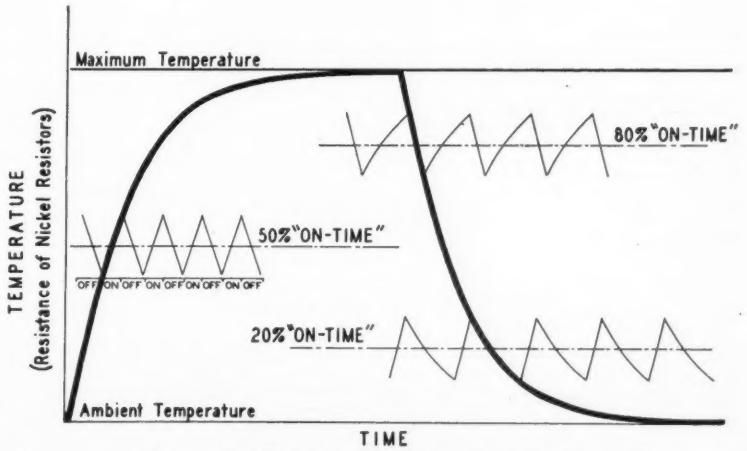


Fig. 7. Resistor-heater assembly heating and cooling curves.

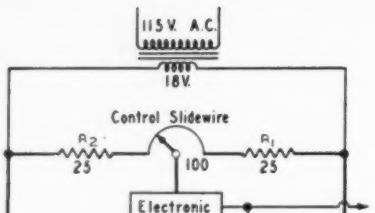


Fig. 8. "Percentage on-time" type controller with proportional and reset action.

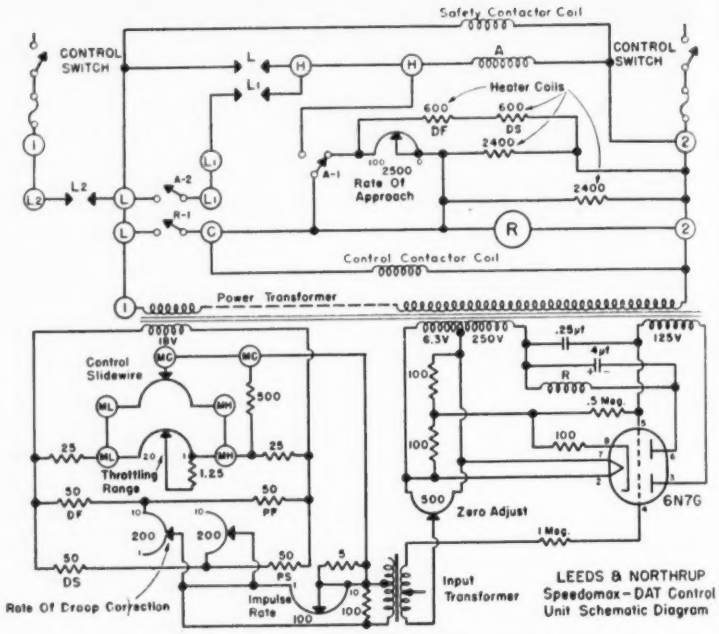


Fig. 9. Complete circuit drawing of "percentage on-time" type controller.

its temperature rises, R_s must continue to stay ahead to maintain the ratio

$$\frac{R_s}{R_t} > 1$$

The continuing increase in the "percentage on-time" will continue until the specimen temperature is again at the set point.

The mass of R_t unit determines the reset rate, or how fast it is capable of "chasing" R_s. Since it is difficult to vary the mass, it is more simple to build a bridge with two sets of resistor-heater assemblies, in one case R_t has a solid steel core and the other one, R_s is a hollow-brass tube. Two ganged rheostats allow various reset rates to be obtained by utilizing a weighted average of the two units.

Adjustment of proportional band is accomplished by varying the shunt on the control slidewire. Impulse rate is adjusted by varying the sensitivity of the a-c electronic phase-sensitive amplifier. Fig. 9 is a schematic drawing of the complete unit.

Fig. 10 shows the 100-ohm control slidewire and limit switches of the electric controller. Fig. 11 is a back-view of the electric control unit showing the four resistor-heater assemblies. *PF* and *DF* are the proportional and droop units associated with fast droop and *PS* and *DS* are the units used for the slow rate of droop correction.

Auxiliary Control Switches

Control switches L and L_1 are for two purposes, namely (1) to apply full power to the furnace should the temperature drop 0.5 in. below the set point, and (2) to maintain full power on heat-up till the temperature is within one-quarter inch of the set-point.

During the long heating period of the furnace, the resistor-heater assemblies of the control bridge will have reached their limit temperature. Consequently, upon initially arriving at the set point the unit would operate with 100 per cent on-time. Since in many cases this is not desired, it is advantageous if one can select the initial "percentage on-time". This is accomplished by limiting the maximum temperature of the heavy base droop correction resistor-heater assemblies by inserting in series with the heaters a rheostat calibrated in percentage on-time.

The rheostat is shorted out after the temperature arrives within 0.25 in. of the set point by L and L_1 contacts. After that, the droop correction control action adjusts the temperature of these units to the value which provides the correct "percentage on-time" to maintain the temperature at the set point. Contact L_2 is a safety contact set to open 0.25 in. above the set point. This opens both the control contactor

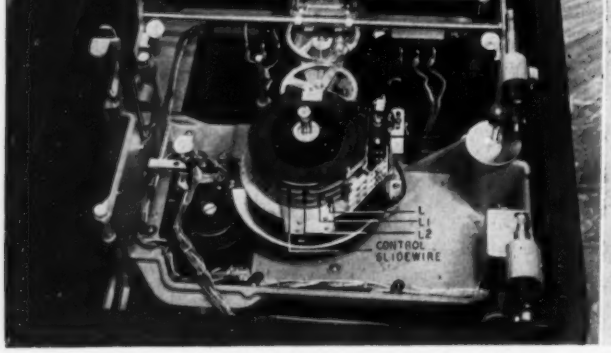


Fig. 10. View of control slidewire and control switches.

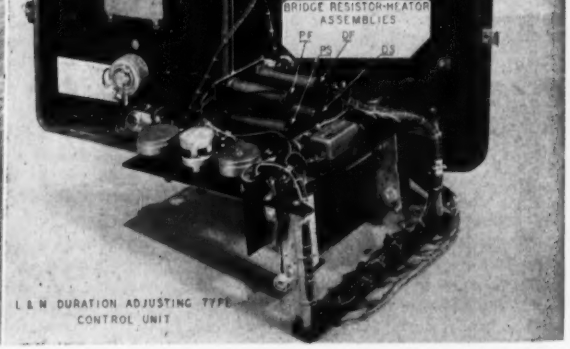


Fig. 11. Back view of "percentage on-time" type control unit showing the four resistor-heater assemblies.

and a second safety contactor in case the control contactor is stuck.

Selection of Control Contactors

In the case of the "percentage on-time" type of temperature controller, the final control element is a standard contactor or relay capable of handling the heavy furnace current. In all cases, two contactors wired in series are used as a safety measure. With the use of the over-temperature safety contact L_n the controller will provide non-proportional on-off control at a point 0.25 in. above the set point.

All dual contactor units in use at the present time are of the enclosed mercury type rated at 30 amperes, 115 volts, 60 cycles; and 20 amperes, 230 volts, 60 cycles.

No failures have occured in the 16 sets installed in the creep laboratory, although out of a number of additional units installed in the Laboratory, a considerable number of failures have occurred. The manufacturer has assured us that this was the result of a bad lot in manufacturing.

It has been found that the mercury type relays are desirable due to their silent operation.

Conclusion

The creep testing laboratory has been in operation a sufficient length of time to show that the design, as discussed in this paper, has been a sound one. No trouble has been experienced with the instrumentation as far as component failures or the inability to measure or control to the desired limits. It has been necessary to resort to manual reset at low temperatures in the vacuum furnaces due to the long lags. The resultant temperature control still appears to be within 1° C. No conclusive data is yet available that would show a definite change in the calibration of the Chromel-Alumel thermocouples, even though they are working at both high temperature and high vacuum.

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A Review of the Electric Displacement Gages Used in Railroad Car Testing

By WILLIAM KNEEN*

IN the last few years, the trend of our mechanical engineers, like those of other companies, has been to utilize electrical methods to aid in the analysis of their problems. Recording oscillographs were purchased, and in addition to strain gages and accelerometers, a need arose for good displacement gages.

One of the first electrical means for measuring displacement consisted of a hairpin shaped piece of spring steel with an SR-4 electrical bonded wire strain gage cemented to it (Fig. 1).

Pullman-Standard Car Mfg. Co., Hammond, Ind.

Presented at the Sixth Annual Conference of the Instrument Society of America, at Houston, Texas, Sept. 10-14, 1951.

Some of the applications of this gage were the measurement of truck spring deflection, roof deflection over door openings, and other similiar problems.

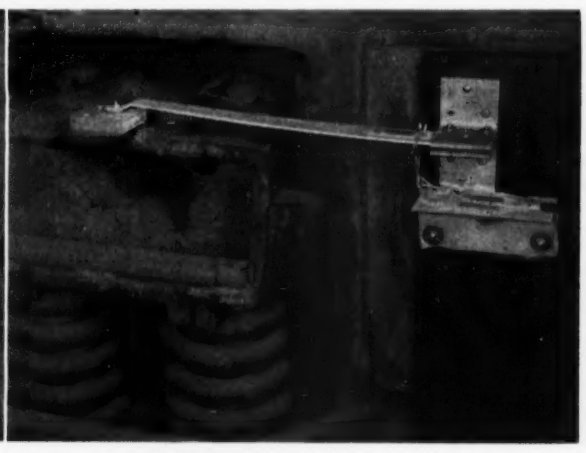
One of the physical characteristics of this gage or of any electrical or mechanical system is its natural frequency. When a stimulus containing components, equal in frequency to the natural frequency, is applied to the system an abnormally large response is apt to occur. This phenomenon is known as resonance. If insufficient damping is present in the system, the response at these natural frequencies will be such as to obscure smaller variations at other frequencies.

The hairpin was necessarily quite flexible in order to accomodate sizeable deflections and, therefore, had a rather low natural frequency. Abnormal response at the natural frequency and its harmonics made the desired information unintelligible. The above considerations limit the usefulness of hairpin gages in dynamic tests. They are, however, quite useful in static tests.

Strain Gage Mounted on Beam

In a similar fashion to the hairpin gages, a strain gage mounted on a beam with a fairly high natural frequency which can be pre-loaded against one of the members being displaced, provides a means of measuring displacements providing they are not too great (Fig. 2). Gages of this type are fairly durable and reliable.

Fig 1. The hairpin displacement gage utilizing SR-4 bonded wire strain gages.



Fg. 2. The pre-loaded cantilever beam gage utilizing SR-4 bonded wire strain gages.

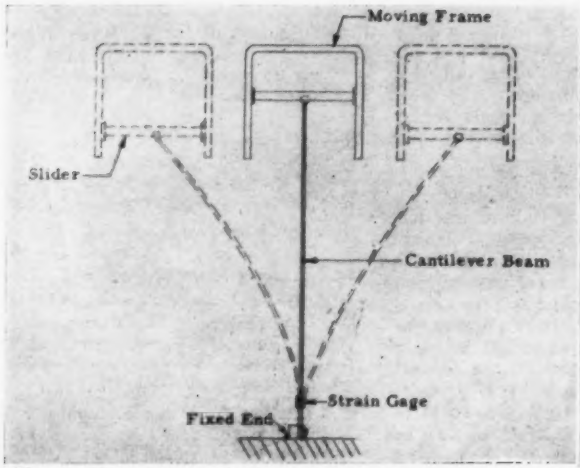


Fig. 3. The cantilever beam may have its unsupported end guided to follow a desired motion as shown.

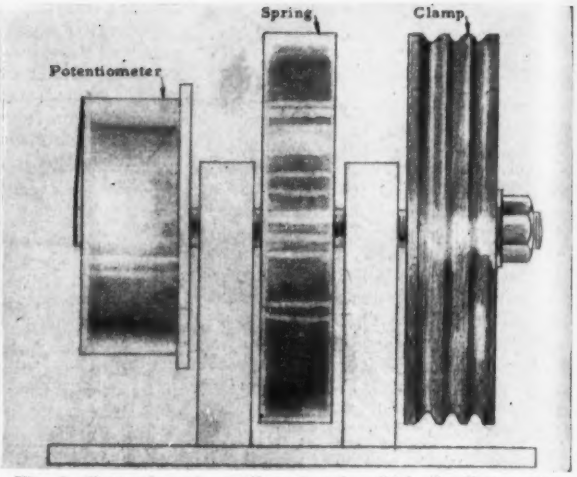


Fig. 5. Shown here is another way in which the linear wire wound potentiometer may be used as a displacement gage.

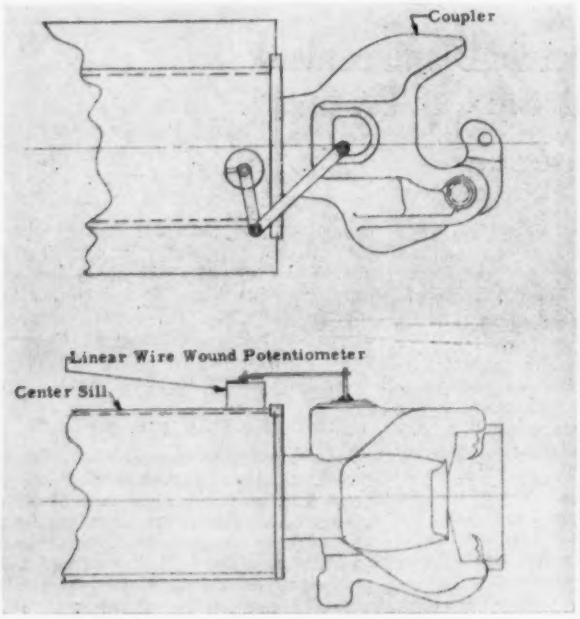


Fig. 4. The use of a linear wire wound potentiometer as a displacement gage is shown in the above sketch.

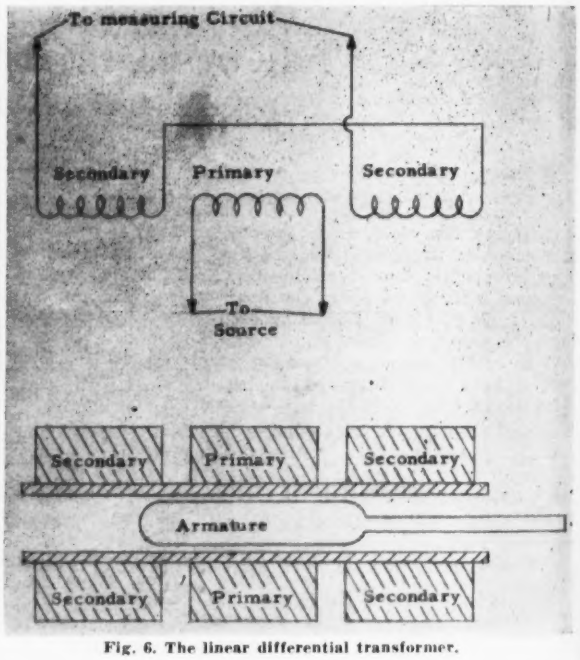


Fig. 6. The linear differential transformer.

They can be precalibrated by determining what resistance connected in parallel to the active gage or the dummy gage gives a trace deflection equal to that obtained when the beam is displaced definite known distances or merely displaced definite known distances with oscillograph records made for each position. The pre-calibration makes this and the hairpin gage easy to calibrate under conditions where it might be difficult to calibrate other types of gages.

Another possibility, instead of the pre-loaded beam, is the cantilever, whose free end is guided or forced to follow the displacement to be measured (Fig. 3). A strain gage mounted on this beam and calibrated in the same manner as the pre-loaded beam provides an excellent displacement gage. Either of these beam gages is suitable for dynamic as well as static tests; including tests on the road.

Care must be exercised in the design of the gage. The place of application of the gage often limits the length of beam possible. The deflection necessary in order to follow the total movement being measured determines the necessary flexibility of the beam. The maximum stress in the beam must always be well below the proportional limit of the material being used.

Oftentimes unwanted movements in directions other than that being measured are present. If insufficient care is exercised in the design of the beams, these other movements can introduce error in the measurement of the desired component. It is usually possible, with some thought, to arrive at a satisfactory solution in either the preloaded or guided cantilever beam.

Linear Rotary Potentiometer

Another type of electrical displacement gage consists of a linear, rotary, wire-wound potentiometer parelleling two arms of a Wheatstone Bridge in combination with a suitable mechanical linkage for converting straight line movement into rotation. An example of this type of device is shown in Fig. 4. For calibration the gage is moved definite known amounts and records are made.

This gage was used in the measurement of such quantities as draft gear closure and truck spring deflection, among others. It was soon apparent that difficulty arose due to the inertia of the mechanical linkages used. Necessarily these gages were unable to measure faithfully displacements where the rise time of the function was short.

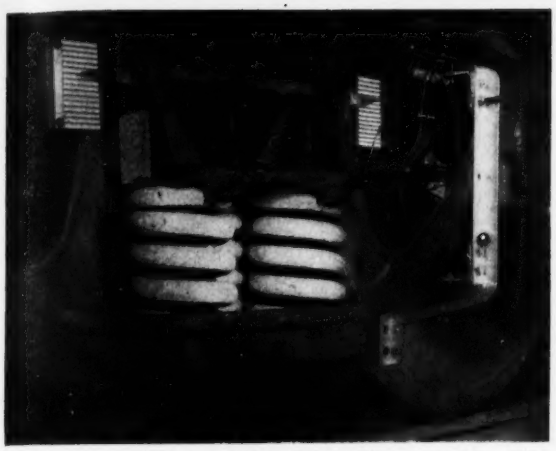


Fig. 7. The slidewire potentiometer used as a truck spring deflection gage.

Fig. 8. The slidewire potentiometer used a draft gear closure gage.

A further difficulty arose from the fact that the potentiometers used were not designed for such service, and without additional support for the shaft, breakage was frequent.

The linear rotary potentiometer has also been utilized in a gage of the type shown in Fig. 5. Here the potentiometer shaft has a reel on which a cord or wire may be wound. The shaft is also spring-loaded with a heavy torsion spring. The entire unit can be enclosed in a durable case with adequate bearings on the shaft. The unit can then be attached to one of the two

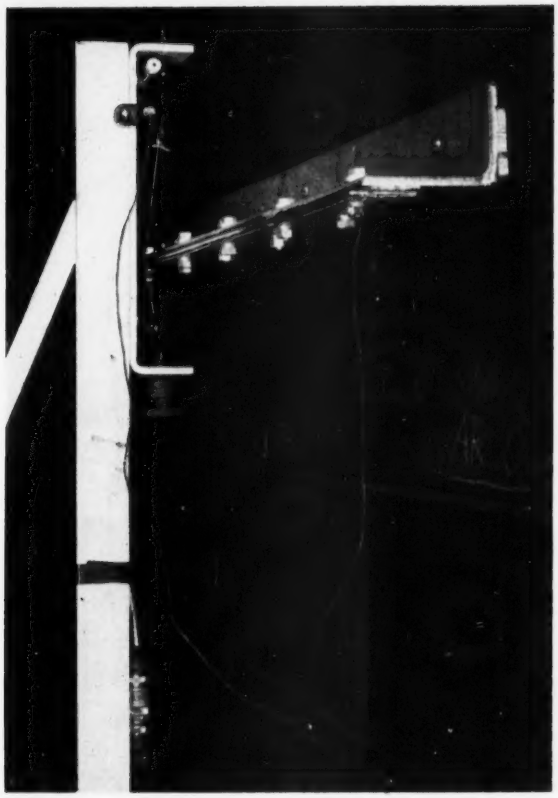


Fig. 9. The slidewire potentiometer used as a vertical car body movement gage.

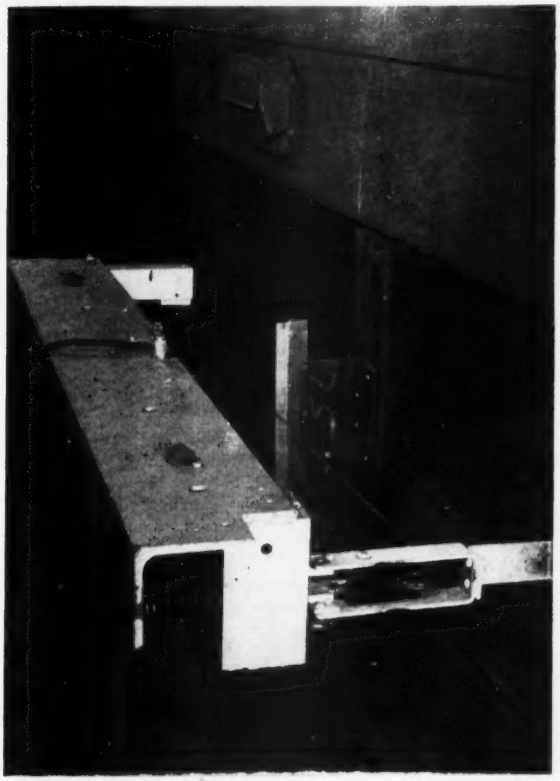


Fig. 10. The horizontal displacement of the struck car in impact tests can be measured with the above slidewire potentiometer.

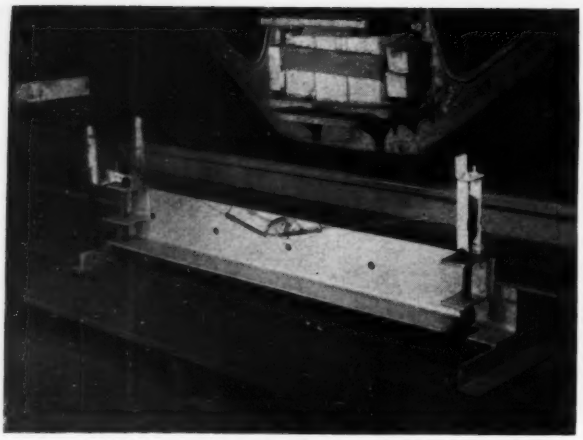


Fig. 11a. The horizontal displacement and/or velocity of the striking car in impact test is measured with the slidewire potentiometer. As shown in the photo the actuator and contact knife are approaching the slidewire.

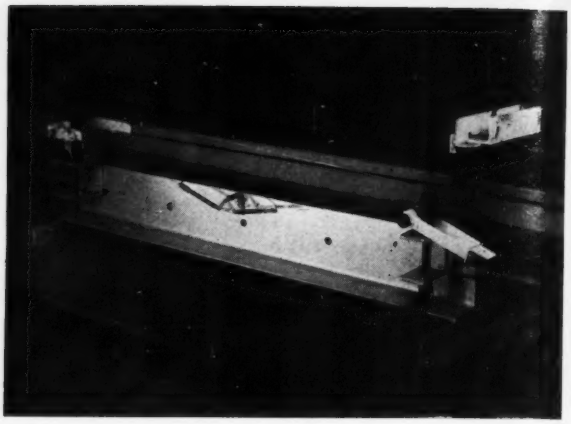


Fig. 11c. Again the striking car displacement gage is shown in the photo. The contact knife and actuator have left the slidewire.

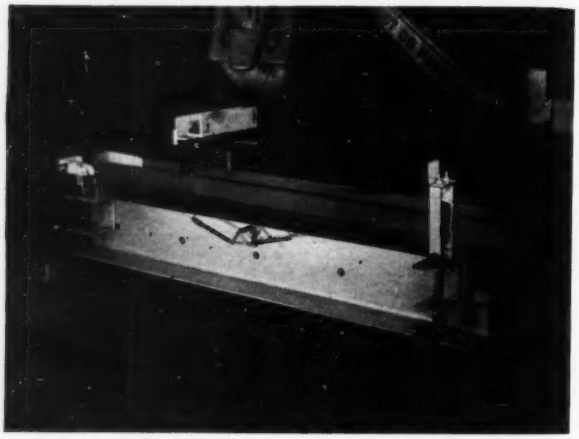


Fig. 11b. Again the striking car displacement gage is shown in the photo. The contact knife is moving along the wire.

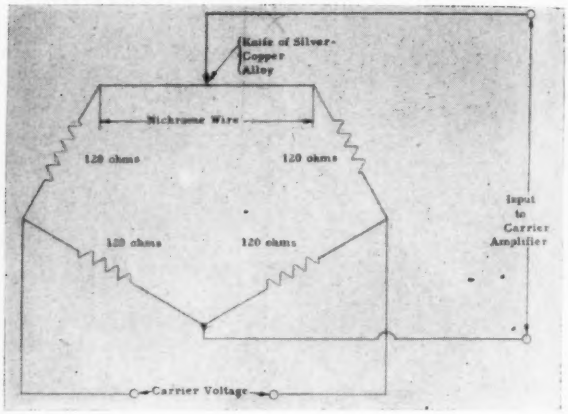


Fig. 12. Schematic diagram of slidewire potentiometer used in Wheatstone Bridge circuit as displacement gage.

members having relative movement while the end of the cord is attached to the other.

The main advantage of this gage is that it can be made into such a unit that it can be used on various tests without modification. The potentiometer again can be connected in parallel with two arms of a Wheatstone Bridge. The gage can be calibrated or precalibrated in the same manner as for beams or hairpins.

The limitations on the use of this gage are: (1) the instrument will not cancel out components of displacement in directions other than the desired, (2) the device is not suitable for the measurement of very small displacements, and (3) functions with rapid rise times or rapid return times will not be faithfully reproduced if the spring rate is not fast enough.

Linear Differential Transformer

In the course of the investigations, the linear differential transformer was encountered (See Fig. 6). This unit consists of three coaxial coils wound along an insulating coil form. A magnetic core or armature is supported in such a manner that it can be moved along the axis of the coils. The center winding is the primary and is connected to an a-c source of gage voltage.

The two end windings are connected in series opposition and their output is connected to the measuring circuit. There is some position of the magnetic core within the coils such that the output voltage is a minimum, since the induced emf in each half of the secondary is equal in magnitude but 180° out of phase. This net output is quite low.

The mechanical system measured moves the core relative to the coil. The voltage across the secondary toward which the core is moved increases while the voltage across the other secondary decreases. The net output then increases. This net output is linear within a limited range of displacements for a gage voltage of fixed frequency, the frequency being within certain limits.

The limitations on the use of this device are numerous. In general, the usefulness of the gage is limited to small displacements. Movements in directions other than that being measured cause serious problems in the design of suitable linkages to operate the linear differential transformer. Inasmuch as the differential transformer is not a part of a bridge circuit, while all the other gages normally used are, it is inconvenient.

When the primary source was supplied from certain electronic oscillators, serious regulation of the oscillator voltage was noted. If this was a common source for other gages, interaction between gages would be present. Further, the output requires demodulation in order not to clutter up valuable space on oscillograph records with a modulated wave form.

The presence of magnetic materials in close proximity to the transformer is also a serious limitation on its usefulness as a displacement gage. The linear differential transformer is still under investigation at our laboratory and as yet has not been used to any great extent in our testing.

Slidewire Potentiometers

While investigation of the linear differential transformer was under way, slidewire potentiometers were tried as displacement gages. Surprising success was achieved for certain types of

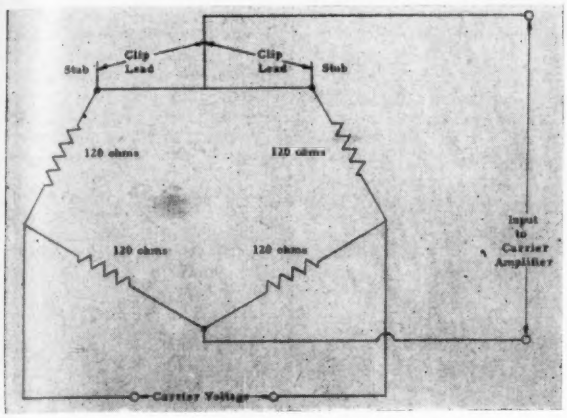


Fig. 13. Calibration of slidewire potentiometer shown schematically. (1st step)

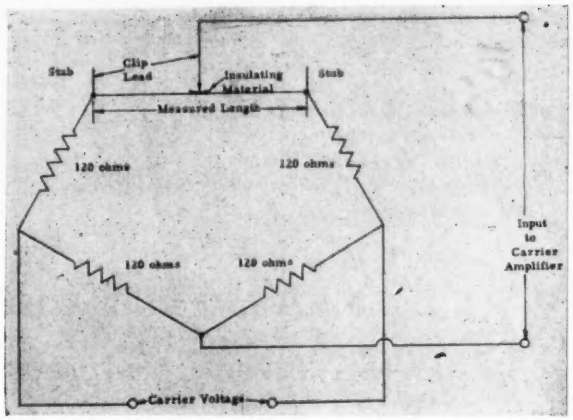


Fig. 14. Calibration of slidewire potentiometer shown schematically. (2nd step)

displacements by the use of these, the simplest of electrical displacement gages.

Some examples of slidewire potentiometer displacement gages are the truck spring deflection gage, Fig. 7; the draft gear closure gage, Fig. 8; the vertical car body movement gage, Fig. 9; and the horizontal car movement gage, Figs. 10, 11a, 11b, and 11c. The slope of the records obtained from horizontal car movement gages is excellent for the measurement of velocity.

The construction of these gages consists merely of a length of nichrome wire suspended between two insulators of plastic or phenolic. Springs are inserted between the insulators and the supporting frame to maintain suitable tension on the nichrome wire. This assembly is mounted on one of two bodies in question.

A contact or knife of silver-copper alloy fastened between two layers of plastic or phenolic insulation is mounted on the second body. When relative movement of the two bodies occurs, the contact moves along the nichrome wire. The circuit of the gage is shown in Fig. 12.

The diameters of nichrome wire used depend on the lengths of the gages in question and the maximum resistance change that can be withstood in the amplifier input circuit without overloading the amplifier. In general, it was found possible to standardize on two wire diameters.

0.032-inch diameter wire, with a resistance of 0.674 ohms per foot, was used on all gages except those for measuring horizontal car displacement relative to ground. Here the gage length is long (43 inches) and, with 0.032-inch diameter wire, the total resistance change (2.42 ohms) was too great. Thus, in this case, 0.064-inch diameter wire with a resistance of 0.168 ohms per foot is used.

Calibration of Slidewire Type

The calibration method for such a gage is simple. After construction, fixed contacts (copper wire stubs) are soldered to the ends of the nichrome wire the resistance of which is small compared to the fixed resistors (Fig. 13). The distance between these stubs (or the length of the nichrome wire) is accurately measured and recorded as a constant of the gage. For calibration, two short oscillograph records are made.

For the first, both stubs are shorted to the contact knife blade, removing all the nichrome wire from the circuit as shown in Fig. 13. The bridge circuit is now balanced. An oscillograph record is made.

The contact knife blade is now insulated from the nichrome wire and is now connected to the stub at one end of the wire only, as shown in Fig. 14. Another oscillograph record is made.

The trace deflection between these two records corresponds to contact movement over one half of the measured length between stubs, since in actual use any resistance removed from one arm of the bridge is inserted in the adjacent arm of the bridge.

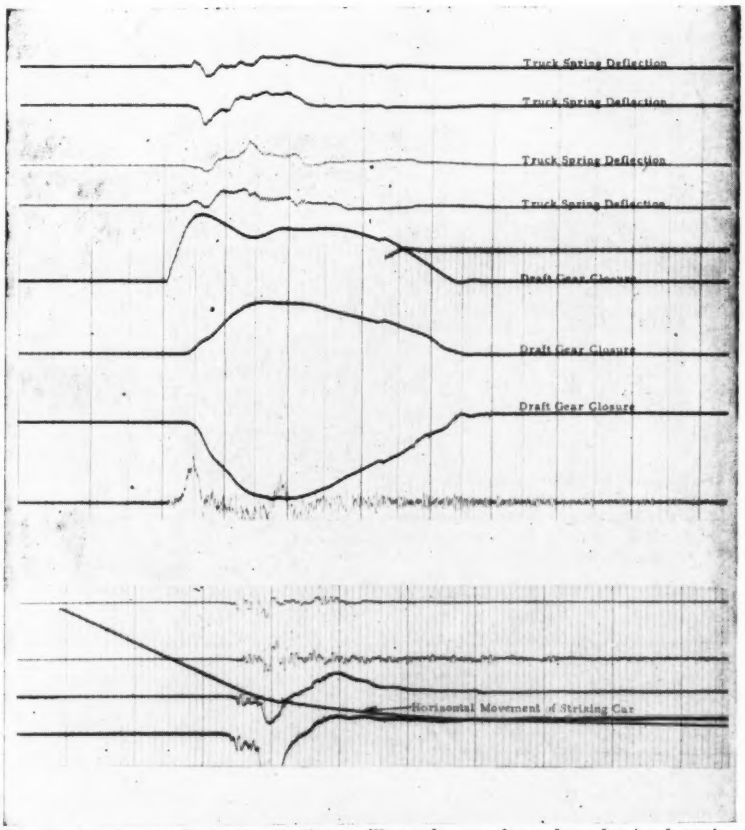


Fig. 15. Sample records from recording oscillographs are shown here for truck spring deflection, draft gear closure, and horizontal car movement.

Calibration may also be achieved by moving all of the nichrome wire from one arm of the bridge to the adjacent arm. In this case, the records correspond to movement over the entire length of the nichrome wire.

Considerable information has been successfully obtained by these slide-wire potentiometers and they are recommended for dynamic measurements of displacements from about one inch to several feet. Sample oscillograph records of truck spring deflection, draft gear closure, and horizontal car movement obtained with these gages are shown in Fig. 15.

Like other displacement gages, these also have limitations. The main difficulty being that they are easily damaged by shop help working on railroad cars, and by conditions encountered when tests are being run out on the road. Calibration also presents some difficulty in road testing; however, these gages have proved to be excellent on impact tests in our laboratory.

TENTATIVE TECHNICAL PROGRAM

ISA Seventh National Instrument Conference

September 8-12, 1952 – Public Auditorium, Cleveland, Ohio

Monday, September 8
10:00 A.M.

ISA Session on Instrumentation for Production Processes. Room B. Chairman, Tom Pierson (Corn Products Refining Co., Corpus Christi, Texas). Recorder, E. H. C. Brown, (Joseph E. Seagram & Sons, Inc., Louisville, Ky.)

"Quality Control for Alcoholic Beverage Production," by Donald A. Brandt (Schenley Distilleries, Cincinnati, O.) Paper No. 52-1-1

"Instrumentation in the Food Proccessing Field," by Dean Foster (U. S. Testing Company, Inc., Indianapolis, Ind.) Paper No. 52-1-2

"The Mercury Jet Switch and its Application," by R. G. Hoff (General Electric Co., Richland, Wash.) Paper No. 52-1-3

* * *

ISA Session on Instrumentation for Testing. Room A. Chairman, H. F. Rondeau (American Meter Company, Erie, Pa. Recorder, D. C. Little, (Army Medical Research Lab., Ft. Knox, Ky.)

"A New Type of Package Hygrometer," by K. C. Coon (General Mills, Inc., Minneapolis, Minn.) Paper No. 52-2-1

"A Pneumatic Sine-Wave Generator for Process Control Studies," by D. P. Eckman and S. C. Moise (Case Institute of Technology, Cleveland, O.) Paper No. 52-2-2

"Inductive Gage for the Measurement of load," by H. C. Roberts (University of Illinois, Urbana, Ill.) Paper No. 52-2-3

"Rapid Evaluation of Piezo-electric Response of Titanate Transducers," by H. I. Oshry and J. M. Minkowski (Erie Resistor Corp., Erie, Pa.) Paper No. 52-2-4

* * *

ISA Session on Analysis Instrumentation. Room C. Chairman, Dr. B. W. Thomas (Humble Oil & Ref. Co., Baytown, Texas)

"Electrochemical Instruments for Gas Analysis," by Dr. M. G. Jacobson (Mine Safety Appliances Co., Pittsburgh 8, Pa.) Paper No. 52-3-1

"A Specific Oxygen Gas Analyzer," by Charles G. Fellows (Carbide & Carbon Chemicals Co., So. Charleston, W. Va.) Paper No. 52-3-2

"Analytical Control of Butylene Dehydrogenation Catalyst Regeneration with Phillips' Automatic Infrared Analyzer," by K. V. Kratochvil and D. E. Berger (Phillips Petroleum Co., Bartlesville, Okla.) Paper No. 52-3-3

* * *

ISA Session on Instrument Operation and Maintenance, Room South Hall A. Chairman, George N. Ehly (Atlantic Refining Co., Phila., Pa.)

"Design for a Modern Instrument Shop," by G. L. Slocum, (Sun Ray Oil & Refining Co., Duncan, Okla.) Paper No. 52-4-1

"Progress Report—Instrument Shop Practices Committee," by R. L. Nichols (Magnolia Petroleum Co., Beaumont, Texas) Paper No. 52-4-2

"Review of Recommend Practice for Handling Mercury," Group Discussion Chairman, George N. Ehly (Atlantic Refining Co., Phila., Pa.)

"Recording Instrument Precision Attained on the Natural Gas Supply to the New York Area," by A. K. Joecks (Consolidated Edison Co., New York, N. Y.) Paper No. 52-4-3

"Field Calibration of Pressure Gages," by G. A. Pettit (Michigan Chemical Corp., St. Louis, Mich.) Paper No. 52-4-4

"Progress Report—Instrument Calibration Techniques Committee," by G. A. Pettit (Michigan Chemical Corp., St. Louis, Mich.) Paper No. 52-4-5

* * *

ISA Session on Aeronautic Instrumentation. Room South Hall B. Chairman, R. E. Tozier (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.)

"A New Instrument Rate Table," by M. J. Harpole (General Mills, Inc., Minneapolis, Minn.) Paper No. 52-5-1

"Radio Tracking Telemetering System," by E. R. Van Krevelen (General Mills, Inc., Minneapolis, Minn.) Paper No. 52-5-2

"Force Measurement on Balloon Plastics and Parachute Cloth by Means of Strain Gages," by J. J. Ryan (General Mills, Inc., Minneapolis, Minn.) Paper No. 52-5-3

"Miniature Pressure Transducers with High Frequency Response," by T. R. Wrathall, J. C. Kyle and G. W. Coon (NACA Ames Aeronautical Laboratory, Moffett Field, Calif.) Paper No. 52-5-4

* * *

ISA Session on Instrumentation for Inspection and Gaging. Room South Hall C. Chairman, Warner Seely (Warner & Swazey Co., Cleveland, O.)

"A Quarter Century of Progress in Industrial Measurement," by James Abbott (Micrometrical Mfg. Co., Ann Arbor, Mich.) Paper No. 52-6-1

"Air and Electric Instruments and their Application to Automatic Gages," by W. Faye Aller (Director of Research, The Sheffield Corp., Springfield St., Dayton, Ohio) Paper 52-6-2

Monday, September 8
2:30 P.M.

ISA Panel Forum "Frontiers of Instrumentation" Moderator, David Dietz, (Cleveland Press, Cleveland, Ohio)

Panel Members: Lawrence P.Lessing, (Fortune Magazine, New York City), Gerard Piel, (Scientific American, New York City), Harry Lee Waddell, (Factory Management and Maintenance, New York City.)

* * *

ISA Session on Analysis Instrumentation. Room C. Chairman, Thomas C. Wherry (Phillips Petroleum Co., Bartlesville, Okla.)

"A Recording Infrared Analyzer," by V. N. Smith (Shell Development Co., Emoryville, Calif.) Paper No. 52-7-1

"Capacitance Sample Cell for Measurement of Dielectric Constant," by Dr. B. W. Thomas (Humble Oil & Ref. Co., Baytown, Texas.) Paper No. 52-7-2

"A Recording Titrator for Macro and Micro Titrations," by M. T. Kelley, J. L. Horton, J. R. Tallackson and F. J. Miller (Carbide & Carbon Chemicals Co., Oak Ridge, Tenn.) Paper No. 52-7-3

* * *

ISA Session on Instrument Operation and Maintenance. Room South Hall A. Chairman, R. L. Hurley, Jr. (E. I. du-Pont de Nemours & Co., Wilmington, Del.)

"Reactivating Flood Damaged Instruments and Controls," by Jack C. Brous (Phillips Petroleum Co., Kansas City

Refinery) & Ivan Dural (Colgate-Palmolive Peet Co., Kansas City, Kansas) Paper No. 52-8-1

"Instrument Mechanic Training," by George A. Larsen (Texas Co., Lockport, Ill.) Paper No. 52-8-2

"Experience with Aluminum Tubing for Instrument Air Connections," by D. W. Humphrey (E. I. duPont de Nemours & Co., Wilmington 98, Del.) Paper No. 52-8-3

"Instrument Installation Practices Progress Report," by H. A. Hulsberg (Blaw-Knox Co., Chem. Plants Div., Pittsburgh, Pa.) Paper No. 52-8-4

"Relief Valve Leak Detection," by G. F. White (Universal Oil Products Co., Chicago, Ill.) Paper No. 52-8-5

"Field Testing of Multipoint Recorders," by H. A. Hulsberg (Blaw-Knox Co., Chem. Plants Div., Pittsburgh, Pa.) Paper No. 52-8-6

Tuesday, September 9
10:00 A.M.

ISA Session on Instrumentation for Production Processes. Room B. Chairman, H. H. Johnson (Consolidated Edison Co., N. Y., N. Y.) Recorder, R. N. Pond, (Taylor Instrument Cos., Rochester, N. Y.)

"Analysis of a Typical Cascade System Involving the Use of Pneumaticset Ratio Relay," by W. R. Bailey (Brown Instrument Div., Minneapolis-Honeywell Reg. Co., Philadelphia, Pa.) Paper No. 52-9-1

"Dynamic Behaviour of Pneumatic Devices," by N. Gould and P. E. Smith, Jr. (Massachusetts Institute of Technology, Cambridge, Mass.) Paper No. 52-9-2

"Step Response as a Short Cut to Frequency Response," by David W. St. Clair (Eastman Kodak Co., Rochester, N. Y.) Paper No. 52-9-3

* * *

ISA Session on Instrumentation for Testing. Room A. Chairman, S. A. Hluchan (Oak Ridge National Laboratory, Oak Ridge, Tenn.) Recorder, H. F. Rondeau, (American Meter Co., Erie, Pa.)

"Small Target Radiation Pyrometer Applications," by Thomas J. Schlottenmeir (Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.) Paper No. 52-10-1

"Important Factors in the Design of Bridge Networks used in Instrumentation," by Paul O. Huss (University of Akron, Akron, Ohio) Paper No. 52-10-2

"The Use of a Zehnder-Mach Interferometer for the Study of Heat Transfer from a Cylinder," by D. L. Doughty and W. H. Giedt (University of California, Berkeley, Calif.) Paper No. 52-10-3

* * *

ISA Session on Medical Instrumentation. Room South Hall A. Chairman Dr. Otto Glasser (Cleveland Clinic, Cleveland, O.)

"Standardization of Hospital Instruments," by Leonard P. Goudy (American Hospital Association, Chicago, Ill.) Paper No. 52-11-1

"Tentative Integration of Principles for the Rationalization of Instrumentation and Methods in Biology and Medicine," by Dr. Raymond Jonnard (Paterson General Hospital, Paterson, N. J.) Paper No. 52-11-2

"Recent Development in Instrumentation for Electrophoresis and Ultra-Centrifugation," by Dr. Kurt G. Stern (Dep't of Chemistry, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.) and Alfred Henley (American Instrument Co., Inc., Silver Spring, Md.) Paper No. 52-11-3

"A Calibrated Bar-Magnet Velocity Meter for Use in Ballistrocardiography," by Dr. J. E. Smith (Civil Aeronautics Administration, Washington, D. C.) Paper No. 52-11-4

* * *

ISA Session on Aeronautic Instrumentation. Room South Hall B. Chairman, I. Warshawsky (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.)

"Considerations Entering Into Selection of Probes for Pressure Measurement in Jet Engines," by Clarence Gettelman (NACA, Lewis Flight Propulsion Laboratory, Cleveland, Ohio) Paper No. 52-12-1

"Effect on Pressure Measurements of the Interaction Among Probes, Supports, Duct Walls and Jet Boundaries," by Lloyd N. Krause (NACA, Lewis Flight Propulsion Laboratory, Cleveland, Ohio) Paper No. 52-12-2

"Thermocouples for Jet Engine Gas —Temperature Measurement," by Marvin D. Scadron (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.) Paper No. 52-12-3

"Electrical Techniques for Lag Compensation of Thermocouples Used in Jet Engine Gas — Temperature Measurement," by Charles E. Shepard (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.) Paper No. 52-12-4

"Applications of the Constant Temperature Hot-Wire Anemometer to the Study of Transient Airflow Phenomena," by James B. Laurence (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.) Paper No. 52-12-5

* * *

ISA Session on Geophysical Instrumentation. Room South Hall C. Chairman, Dr. David S. Muzzey, Jr. (U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.)

"Simple Short Period Vertical Seismometer," by Roger M. Wilson and A. E. Lamison (Coast and Geodetic Survey, Washington, D. C.) Paper No. 52-13-1

"An Analog Computer for the Rapid Computation of Potential-Field Data," by Dr. S. Kaufman (Shell Oil Company, Houston, Texas) Paper No. 52-13-2

"Field Seismograph with Electrically Adjustable Parameters," by Ernest R. Kolsrud (Ordnance Engineering, Inc., Rockville, Md.) Paper No. 52-13-3

"NOL Vector Airborne Magnetometer," by E. O. Schonstedt and H. R. Irons (U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.) Paper No. 52-13-4

"Electromagnetic Model Experiments" by R. L. Caldwell, C. I. Beard, E. N. Skomal, A. R. Orsinger, and G. L Hoen, (Magnolia Petroleum Company Field Research Laboratories, Dallas, Texas) Paper No. 52-13-5

"Report on the O.N.R.—N.R.C. Symposium on Oceanographic Instrumentation at the Scripps Institute," by Dr. John Isaacs (Scripps Institute of Oceanography, La Jolla, Calif.) Paper No. 52-13-6

Tuesday, September 9
2:30 P.M.

ISA Session on Instrumentation for Testing. Room A. Chairman, G. N. Krouse, (Krouse Testing Machine Co., Columbus, Ohio) Recorder, S. A. Hluchan (Oak Ridge Nat'l Lab., Oak Ridge, Tenn.)

"A Versatile Miniature Flush-Diaphragm Pressure Transducer," by Julian Delmonte (Consolidated Engr. Corp., Pasadena, Calif.) Paper No. 52-14-1

"Automatic Electronic Controller for Vibration Testing of Structural Members," by Jacob S. Brown, (Syracuse University, Syracuse, N. Y.) Paper 52-14-2.

"Performance Evaluation of Special Red Tubes," by H. J. Prager, (Radio Corporation of America, Harrison, N. J.) Paper 52-14-3.

"A Precision Pressure Balance," by John F. Kinkel, (Consolidated Engineering Corp., Pasadena, Calif.) Paper 52-14-4

Wednesday, September 10
10:00 A.M.

ISA Session on Instrumentation for Production Processes. Room B. Chairman, Earl M. Seagrave, Jr. (Celanese Corp. of America, Rock Hill, S. C.) Recorder, C. A. Hansen, Jr., (General Electric Co., Schenectady, N. Y.)

"Force Balance Pressure Transmitters Used to Detect Column Flooding," by Gordon W. Swinney (Phillips Petroleum Co., Phillips, Texas) Paper No. 52-15-1

"Plant Control by Gas Analysis," by A. W. Angerhofer and B. M. Dewey (Air Reduction Co., New York 17, N. Y.) Paper No. 52-15-2

"Development of a Universal Controller for Liquid Flow," by Hoel L. Bowditch (The Foxboro Co., Foxboro, Mass.) Paper No. 52-15-3

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ISA Session on Instrumentation for Testing. Room A. Chairman, R. P. Wehrle (International Harvester Co., Chicago, Ill.) Recorder, G. N. Krouse (Krouse Testing Machine Co., Columbus, Ohio)

"The Schlieren Apparatus as a Research Tool in the Welding Industry," by Walter B. Moen (Air Reduction Company, Murray Hill, N. J.) Paper No. 52-16-1

"Instrumentation for the Transient Testing of Accelerometers," by Pierre M. Honnell (Washington University, St. Louis, Mo.) Paper No. 52-16-2

"Design of Strain Gage Pressure Indicator," by Yao Tzu Li (Massachusetts Institute of Technology, Cambridge, Mass.) Paper No. 52-16-3

"A Continuous Ultrasonic Viscometer for Automatic Process Control," by Stanley R. Rich and Wilfred Roth (Ultra-Viscoson Corporation, East Hartford, Conn.) Paper No. 52-16-4

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ISA Session on Medical Instrumentation. Room South Hall A. Chairman, Dr. Harold J. Morowitz (National Bureau of Standards, Washington, D. C.)

"Engineering of Gait Analysis and Human Mechanics Instrumentation. Applications to Patients with Hemiplegia," by Morton Marks, M. D. (Assistant Professor of Clinical Neurology, New York University College of Medicine, New York, N. Y.) and Gerald G. Hirschberg, M. D. (Director of Physical Medicine and Rehabilitation, Oakland Veterans Admin. Hospital, Oakland, Calif.) Paper No. 52-17-1

"Magnetic Measuring Instruments in Medicine," by George D. Butler (Beckman Instruments, Inc., New York, N. Y.) Paper No. 52-17-2

"Instrumentation in the Study of Human Locomotion," by Alan Nathan (Research Assistant, New York University, College of Engineering) and Renato Cantini (Research Coordinator, New York University, College of Engineering) Paper No. 52-17-3

"The Orthoptic Micrscope Interferometer: Theory, Standardization, Applications to Precision Interferential Refractometry," by Dr. Raymond Jonnard (Paterson General Hospital, Paterson, N. J.) Paper No. 52-17-4

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ISA Session on Aeronautic Instrumentation. Room South Hall B. Chairman, N. D. Sanders (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.)

"A Digital Automatic Multiple-point Pressure Recording System," by Elmer Sharp (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.) Paper No. 52-18-1

"A High Speed Potentiometer for Recording on Punched Paper Tape," by Richard Smith (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.) Paper No. 52-18-2

"Punched Card Computation of Research Data," by Joseph H. Rawlings (NACA, Lewis Flight Propulsion Laboratory, Cleveland, O.) Paper No. 52-18-3

"Instrumentation for Automatic Plotting and Integrating of Airflow Measurement," by Bruce Miller (Pratt and Whitney Aircraft Co., East Hartford, Conn.) and Richard Perley (United Aircraft Company, East Hartford, Conn.) Paper No. 52-18-4

Wednesday, September 10
2:30 P.M.

ISA Special General Instrumentation Session. Room: South Hall C. Chairman, E. C. Lloyd (Office of Basic Instrumentation, NBS, Washington, D. C.) Recorder, Professor H. L. Mason (Iowa State College, Ames, Iowa)

"A Sub-Audio Time Delay Circuit", by C. D. Morrill, (Goodyear Aircraft Corporation, Akron, O.) Paper 52-19-1

"A Simple Instrument for Evaluating Correlation Functions," by Allen H. Schooley, (Naval Research Laboratory, Washington, D. C.) Paper 52-19-2

"Temperature and Strain Recorder," by Harry Stern, (Allegany Instrument Co., Cumberland, Md.) Paper 52-19-3

"Design and Testing of a Linear Resistance Damping Device to Suppress Fluctuation in Venturi Meter Gages," by Lloyd O. Timblin, Jr., (U. S. Dept. of Interior, Bureau of Reclamation, Denver, Colo.) Paper 52-19-4

Thursday, September 11
10:00 A.M.

ISA Session on Instrumentation for Production Processes. Room B. Chairman, Sam G. Eskin (Robertshaw-Fulton Controls, Greensburg, Pa.)

"Controls as Applied to the Carrier Conduit System," by Ledyard Avery (Carrier Corp., Cleveland, O.) Paper No. 52-20-1

"Aircraft Cabin Temperature Control Systems," by Secor D. Browne (Clifford Manufacturing Co., Waltham, Mass.) Paper No. 52-20-2

"Automatic Control System for an All-Year Air Conditioner," by H. C. Shagaloff (Servel Incorporated, Evanville, Ind.) Paper No. 52-20-3

"Controlling Domestic Oil-Fired Heating Equipment," by C. F. Suesserott (General Electric Co., Bloomfield, N. J.) Paper No. 52-20-4

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ISA Session on Instrumentation for Testing. Room A. Chairman, C. E. Fry (Westinghouse Electric Corp., East Pittsburgh, Pa.) Recorder, R. P. Wehrle (International Harvester Co., Chicago, Ill.)

"Practical Applications of the Electron Microscope," by Sterling Newberry (General Electric Co., Schenectady, N. Y.) Paper No. 52-21-1

"Condensed Indicating-Warning Instrument Display," by Stuart L. Rich (Glowmeter Corporation, Buffalo, N. Y.) Paper No. 52-21-2

"The Instrument Laboratory in Research — Its Operation and Service," by O. L. Linebrink and C. F. Lucks (Battelle Memorial Institute, Columbus, Ohio) Paper No. 52-21-3

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ISA Session on Medical Instrumentation. Room South Hall A. Chairman, Dr. Raymond Jonnard (Paterson General Hospital, Paterson, New Jersey)

"Application of Infrared Spectrometers in Biology and Medicine," by Dr. Van Zandt Williams (The Perkin-Elmer Corp., Norwalk, Conn.) Paper No. 52-22-1

"Stereo-vector-electrocardiography," by Dr. Otto Schmitt (University of Minnesota, Minneapolis, Minn.) Paper No. 52-22-2

"Galvanoplastic Fabrication of Small Precision Parts," by H. C. Roberts (University of Illinois, Urbana, Ill.) Paper No. 52-22-3

"Engineering Principles in Peridontics New Mechanical Aids in the Construction of Precision Splints," by Samuel Kay, D. D. S. (Lebanon Hospital, New York, N. Y.) Paper No. 52-22-4

ISA Session on Radiation Instrumentation. Room C. Chairman, Richard W. Johnston (Atomic Energy Commission, Washington, D. C.)

"Reflection Microscope Dosimeter," by Dr. Francis R. Shonka (Argonne National Laboratory, Chicago, Ill.) Paper No. 52-23-1

"Roentgen Calibrations," by Dr. Harold O. Wyckoff (National Bureau of Standards, Washington, D. C.) Paper No. 52-23-2

"Radioactivity Measurements at National Bureau of Standards," by Dr. W. B. Mann (National Bureau of Standards, Washington, D. C.) Paper No. 52-23-3

"Applications of Visibly Transparent Non-Metallic Electrically Conducting Films," by Leland B. Clark, Sr. (Naval Research Laboratory, Washington, D. C.) Paper No. 52-23-4

"Voltage Regulator and Reference Tubes," by D. L. Collins & R. L. Spalding (Victoreen Instrument Co., Cleveland, Ohio) Paper No. 52-23-5

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ISA Session on Meteorological Instrumentation. Room South Hall B. Chairman, Dr. Christos Harmantas, (U. S. Weather Bureau, Washington, D. C.) "Instrumentation of a "Whirling Arm for True-Air Temperature Calibration to 500 m.p.h.," by R. M. Schecter and R. E. Ruskin (Naval Research Laboratory, Washington, D. C.) Paper No. 52-24-1

"Axial-Flow Vortex Thermometers for True-Air Temperature Measurement in Flight," by R. E. Ruskin, R. M. Shecter, R. D. Merrill and J. E. Dinger (Naval Research Laboratory, Washington, D. C.) Paper No. 52-24-2

"Electronic Dew Point Hygrometer System," by Andrew Combs (Signal Corps Engineering Laboratories, Camp Evans, Belmar, N. J.) Paper No. 52-24-3

Title unknown at this date—by Louvan E. Wood, (Friez Instrument Div., Bendix Aviation Corp., Towson 4, Baltimore, Md.) Paper No. 52-24-4

Friday, September 12
10:00 A.M.

ISA Session on Instrumentation for Production Processes. Room B. Chairman, R. N. Pond (Taylor Instrument Cos., Rochester, N. Y.)

"Instrumentation's Place in the Managerial Organization," by R. H. Berg (International Minerals & Chemical Corp., Chicago, Ill.) Paper No. 52-25-1

"Interchangeable Panels," by D. E. Haase (Pure Oil Co., Crystal Lake, Ill.) Paper No. 52-25-2

"Instrumentation for Detection of Stack Discharges," by Gordon R. Hahn (Consolidated Edison Co., New York, N. Y.) Paper No. 52-25-3

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ISA Session on Instrumentation for Testing. Room A. Chairman, Delmas C. Little (Army Medical Research Laboratory, Fort Knox, Ky.) Recorder, C. E. Fry (Westinghouse Electric Corp., East Pittsburgh, Pa.)

"Apparatus for Measuring Thermal Conductivity of Liquids," by H. L. Mason (Iowa State College, Ames, Iowa) Paper No. 52-26-1

"An Integrating and Differentiating Bar-Magnet Velocity Meter," by T. A. Perls, C. W. Kissinger (National Bureau of Standards, Washington, D. C.) and J. E. Smith (Civil Aeronautics Administration, Washington, D. C.) Paper No. 52-26-2

"A Procedure for Calibration of Vibration Pickup," by Karl Unholtz (M B Manufacturing Co., Inc., New Haven, Conn.) Paper No. 52-26-3

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ISA Session on Instrumentation for Transportation.

Title unknown at this time—by W. F. Tice, (Barber-Colman Company, Rockford, Ill.) Paper No. 52-27-1

"Instruments for Automatic Purposes Over the Years," by W. H. Farr, (Stewart Warner Co., Detroit, Mich.) Paper No. 52-27-2

"Instrumentation for Detonation Research," by W. J. Levedahl, (National Bureau of Standards, Washington, D. C.) Paper No. 52-27-3

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INSTITUTE OF RADIO ENGINEERS INSTRUMENT SESSION

Tuesday, September 9 2:30 P.M.

Room C. Chairman Paul L. Hoover (Case Institute of Technology, Cleveland, Ohio)

"A Peak-reading, Single-pulse Voltmeter" by Edward F. Carome (Case Institute of Technology, Cleveland, Ohio)

"Surface Finish Measurement with Electronics" by Dean R. Christian (Brush Development Co., Cleveland, Ohio)

"A Pre-scheduled Automatic Actuator Control System" by William T. Harregill, Jr. (Lewis Laboratory, NACA, Cleveland, Ohio)

"Symposium—Trend of Electronic Instrumentation in Industry." Participants to be announced.

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AMERICAN INSTITUTE OF PHYSICS and CLEVELAND PHYSICS SOCIETY

Thursday, September 11 2:30 P.M.

Joint Session. Room A. Chairman to be selected.

"Applications of Automatic Control," by Donald Eckman (Case Institute of Technology, Cleveland, Ohio)

"Ultrasonica as a Tool for Industry," Oskar Malliat (Brush Development Co., Cleveland, Ohio)

"Tubeless Amplifiers," Stuart Cocke (Case Institute of Technology, Cleveland, Ohio)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Industrial Instruments and Regulators Division

SESSIONS ON HIGH PRESSURE MEASUREMENT

Tuesday, September 9 10:00 A.M.

A.S.M.E. Session I. Ballroom. Chairman, Wilfred H. Howe (Foxboro Co., Foxboro, Mass.) Recorder, to be selected.

"Introduction to the Symposium on Measurement of High Pressures," by Percy W. Bridgman (Research Laboratory of Physics, Harvard University, Cambridge, Mass.

"The Piston Gage as a Precise Measuring Instrument," by Daniel Johnson (National Bureau of Standards, Washington, D. C.) and Donald H. Newhall (Harwood Engineering, Inc., Walpole, Mass.)

"A High Pressure Wire Gage using Gold Chrome Wire," by Horace Darling (Foxboro, Mass.)

Tuesday, September 9 2:30 P.M.

A.S.M.E. Session II. Ballroom. Chairman, to be selected, Recorder, to be selected.

"An Application of High Pressures in Geophysics: Experimental Rock Formation," by John Handin (Shell Oil Company, Houston, Texas.)

"Techniques and Equipment for the Generation of Dynamic High Pressures," by E. J. Mickevicz (U. S. Naval Ordnance Laboratory, White Oak Silver Spring, Md.)

"A High Speed, High Pressure Gage," by P. L. Edwards (U.S. Naval Ordnance Laboratory, White Oak Silver Spring, Md.)

"Design of High Pressure Pumps," by R. W. Hiteshue and E. C. Clark (U. S. Bureau of Mines, Pittsburgh, Pa.)

"A Sensitive Pressure Controller for High Pressure Service," by P. L. Goldren and A. F. Headrick (U. S. Bureau of Mines, Pittsburgh, Pa.)

Wednesday, September 10 10:00 A.M.

A.S.M.E. Session III. Ballroom. Chairman, P. G. Exline (Exline Engineering Co., Tulsa, Okla.) Recorder, to be selected.

"Summary Paper — High Pressure Developments at Yale University," by Barrett Dodge (Sterling Chemistry Laboratory, Yale University, New Haven, Conn.)

"Influence of Residual Stress on Behavior of Thickwall Closed End Cylinders," by J. H. Faupel and A. R. Furbeck (E. I. du Pont de Nemours and Co., Wilmington, Del.)

"Rupture Disc Design Evaluation and Bursting Tests," by G. R. Prescott (E. I. du Pont de Nemours & Co., Charleston, W. Va.)

"Panel Discussion — Safety Precautions in High Pressure Operation."

Wednesday, September 10 2:30 P.M.

A.S.M.E. Session IV. Ballroom. Chairman, to be selected, Recorder, to be selected.

"Gaskets for High Pressure Vessels," by Andrew R. Freeman (American Instrument Company, Silver Spring, Md.)

"Design and Application of Controlled Volume Pumps for High Pressures," by Donald H. Jones (Milton Roy Company, Philadelphia, Pa.)

"Seals to Minimize Leakage at Higher Pressures," by B. A. Niemeier (Experiment, Inc., Richmond, Va.)

"A Static-Dynamic Load Machine for High ressures," by E. G. Fleischhauer and E. G. Dorsey, Jr., (Experiment, Inc., Richmond, Va.)

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Instruments and Measurements Committee

SESSION ON ELECTRIC RECORDING INSTRUMENTS

Tuesday, September 9 10:00 A.M.

Club Room C. Chairman, A. J. Hornfeck (Bailey Meter Co., Cleveland, Ohio)

"The Requirements and Design for a Direct Current Null Detector," by F. L. Maltby (Bristol Company, Waterburg, Conn.)

"A High Speed Direct Writing Oscillograph," by A. R. Eckels (Oak Ridge National Laboratory, Oak Ridge, Tenn.) and I. S. Blumenthal (Northrup Aircraft, Inc., Hawthorne, Calif.)

"A Smoke Density Recorder Using the Bolometer," by J. F. English (Bailey Meter Company, Cleveland, Ohio.)

SESSION ON ELECTRICAL INSTRUMENTS

Wednesday, September 10 2:30 P.M.

Club Room C. Chairman, H. C. Martin (Ambos Jones Co., Cleveland)

"Electrometer Tubes and Their Applications to Basic Instrumentation," by D. L. Collins (Victoreen Instrument Company, Cleveland, Ohio.)

"Applications of Beta Radiation Gages to Industrial Process Control," by Frank M. Alexander (Industrial Nucleonics Corp., Columbus, Ohio.)

"Shore Based Radar for Harbor Surveillance," by E. J. Isbister (Sperry Gyroscope Co., Great Neck, N. Y.)

ISA's SEVENTH ANNUAL EXHIBIT — DESCRIPTIVE LIST of EXHIBITS and PERSONNEL in ATTENDANCE — CLEVELAND AUDITORIUM Sept. 8-12, 1952

Aircraft Marine Products, Inc.
Harrisburg, Pa. 826

Exhibiting: New Products—Pre-insulated diamond grip terminal for 26-22 wire. **Regular Products**—Pre-insulated diamond grip and plastic-grip terminals; Pre-insulated flag terminals; Hand tools, automachines; Handy Dutchman kits. Design consulation and field engineering service.

In Attendance: Bert Miles, Mgr. Central Div.; W. C. Lange, J. L. Rausch, H. Russel, G. H. Burritt, Branch Salesmen; P. A. Yeager, Jr., Adv. & Sales Prom. Mgr.; B. Haupt, Engr.; S. Froelich, New Products Ass't.

Alina Corporation
New York 13, New York 725

Exhibiting: New Products—Pneumatic chart drive incorporating simple construction, 5 hours running reverse, self-starting, extremely low air consumption, fully automatic, simple orifice cleaning system, dust and corrosion protected; Mechanical chart drive designed to S.A.M.A. specifications, generated gears and pinions assure high torque, trouble-free running, long life, guaranteed to run between —20 F. and 120 F. **Regular Products**—Chart drives for cylindrical, circular and strip charts; Pressure gage movements; Anemometer movements; Time switches; Internal timers; X-ray hand timers; Parts, differentials, pinions, worms, etc.; Sub-assemblies for all industry. Engineering assistance in resolving timing problems.

In Attendance: Fred Senn, Sales Engr.

Allegany Instrument Company
Cumberland, Maryland 823

Exhibiting: New Products—D.c. bridge and amplifier for d.c. bridge circuits and thermocouples, utilizes electronic inversion of d.c. potentials by means of 50-kc. inverter, drift practically zero; Drum camera for study of non-recurrent phenomena; Dynamic temperature and strain recorder for study of non-recurrent phenomena, a complete package including bridge, amplifier, cathode-ray oscillograph, drum camera, automatic calibrator, electronic timer and control circuits. Engineering services on dynamic temperature and strain measurements.

In Attendance: Harry Stern, President; G. William Harrison, V. P. and Chief Engr.

Ambos-Jones Company
Cleveland 14, Ohio 239

Exhibiting: New Products—Weston recording potentiometer features plug-in range standards, multiple chart speed; Weston constant current supply for potentiometers, input voltage 90 to 130 volts, output current 10 ma plus minus 0.1 percent. **Regular Products**—Weston tachometer generator, Ward Leonard relays, Trent calibration tank, Thermoelectric thermocouple connectors, thermocouples and wire Uptegraff transformers.

In Attendance: O. N. Jones, President; H. C. Martin, V. P.; F. W. Kirk, R. T. Adams, Application Engineers; A. G. Koenig, S. M. TAG Div. Weston Elect Inst. Corp.; E. F. Ewing, S. M. Trent, Inc.; J. C. Collins, S. M. Thermo Electric Co.; C. P. Beedle, C. Morgan, Weston Elect. Inst. Corp.

American Institute of Electrical Engineers
New York 18, New York .....Stage

Exhibiting: A.I.E.E. Publications; Information concerning A.I.E.E.

In Attendance: Members of the Local A.I.E.E. Section.

American Meter Company
Philadelphia 2, Pa. 302, 304, 306

Exhibiting: New Products—Dri-Flo recording orifice meter, a mercuryless stainless steel bellows differential pressure instrument supplementing the American Westcott mercury manometer orifice meters. **Regular Products**—Series A-88, 1800# W.P. orifice meter; Series A-88, 5000# W.P. orifice meter; Differential valve; Gas lift meter; Series A-88 pneumatic controller; A-88 pneumatic transmitter; Series 101 pneumatic valve controller. Engineering consultation.

In Attendance: William G. Hamilton, Jr., Pres.; C. Benson Dushane, Jr., V. P. Sales; Arthur F. Benson, V. P. Engg.; Donald C. Wiley, V. P. Research; James H. Satterwhite, Pres. Westcott & Greis; Earl B. Cutter, Jr., Asst. to V. P. Sales; Hilding V. Beck, Application Engr.; Douglas R. Kramer, Adv. Mgr.; Alexander B. Cloud, Daniel J. Harty, James E. Gesner, Bertram S. Truett, District Sales Mgrs.; Cade C. Clover, Mgr. Northern Div. W & G; Harold W. Wahl, Mgr. Southern Div. W & G; Raymond B. Wilmarth, Div. Engr.; Robert B. Gray, Physicist; Norman J. Smith, Engr.; Bennett R. Reed, William R. Kehoe, Engg. Depts.; William R. Rowan, Jr., Robert F. Conners, John D. Van Norden, Louis H. Wise, Clay G. Braswell, Louis V. Hickman, Sales Reps.; Robert A. Hunter, John W. Klein, Jr., Andrew J. Sesock, Frank W. Atkinson, Clarence E. Muehlberg, Sales Engrs.

American Society of Mechanical Engineers
New York 18, New York .....Stage

Exhibiting: Publications of the ASME of interest to persons affiliated with the instrument industry.

In Attendance: Members of the Industrial Instruments and Regulators Division and members of the ASME Cleveland Section.

Anders Lykens Corporation
Lykens, Pa. 733

Exhibiting: New Products—Panel mounting instrument air dryer for installations of 5 to 50 instruments, fully automatic and self contained, can be bolted to rear of regular plant instrument panel with 18 to 20 in. dryer panel flush with plant panel; Desiccant oil filter with removable desiccant charge. **Regular Products**—Anders fully automatic air dryers, 10 to 3000 scfm; Anders semi automatic air dryers, 10 to 2500 scfm.

In Attendance: Edwin W. Anders, Pres.; Arthur W. Dietrich, V. P. & Works Mgr.; Lester A. Wiest, Sec. & Chief Engr.; Walter Ellis, Robert Watts, Cincinnati Mgrs.; Harry Lee, New York Rep. & Adv. Mgr.

Anderson and Sons, Inc.
Westfield, Mass. 217, 219

Exhibiting: New Products—Plant security badge equipment; Polaroid camera and kit for instantaneous photographing and developing of picture; Badge master for immediate assembly of photo into metal frame; Photo trimmer for neat, quick trimming of photograph. **Regular Products**—Complete line of etched, lithographed, embossed and engraved metal products including identification and data plates, dials, panels, scales, rulers and camera components.

In Attendance: R. E. Anderson, President; A. M. Anderson; D. M. Anderson; Francis Webster, Design Engineer.

Ann Arbor Instrument Works
Ann Arbor, Michigan 632

Exhibiting: New Products—Return flow water channel for fluid mechanics demonstration; Badgley hip nail, surgical appliance. **Regular Products**—Photo-elastic equipment; spring ring dynamometers; test specimens; rubber demonstrations models; body strength dynamometer; torsion machine; testing apparatus and strain instruments. **Services**—Materials testing and research; calibration and development of special testing apparatus.

In Attendance: F. L. Everett, Engrg. and Design consultant; R. R. Baucher, Dev. Engr.; A. C. Abernathy, Office Mgr.

Annin Company
Los Angeles 23, Calif. 410, 412

Exhibiting: New Products—Model 1570 and 1580 control valves, high pressure series 900#, 1500# and 2500#, on-off and full throttling control valves in various alloys, temperature service ranges minus 325 to 1000 F; Models 300WW, 600WW, 1500WW ("Wee Willie" series) equipped with Cv selector eliminating necessity for changing trim size for different flow rates, pressures to 15000 lbs., Domotor operated. **Regular Products**—Domotor control valves; Fig. 15 manual valves; Model 1520 cylinder operated valves.

In Attendance: D. H. Annin, Mgr.; R. D. Randall, Chief Engr.; H. R. Bowers, H. A. Woolman, P. B. Shannon, R. W. Welch, W. J. Gallagher, H. W. Johnson, S. H. Isaacs, Sales Engrs.

Askania Regulator Company
Chicago 11, Illinois 415, 417

Exhibiting: New Products—Electro-jet, electro-hydraulic transducer and power amplifier for automatic control and other servo systems; Edge position control, air-hydraulic control for moving webs of paper, plastics, textiles, metals, foils, etc.; Pneumatic summarizer, compact instrument for pilot-flow summarization of fuels. **Regular Products**—Hy-performance hydraulic automatic controls. Development of special purpose servomechanisms; Analog studies.

In Attendance: H. J. Velten, Pres.; H. Ziebolz, V. P.; W. W. Wheeler, S. M.; S. H. Jones, C. E. Hague, E. R. Engstrom, Sales; G. A. Heinemann, Adv. Mgr.

Assembly Products, Inc.
Chagrin Falls, Ohio 305

Exhibiting: New Products—Simplytrol Twin (dual meter control) for control of heat in injection or compression molding or any equipment with two heaters. **Regular Products**—Contact meter relays, automatic controlling pyrometers, indicating pyrometers, panel meters, program control.

In Attendance: Bradley Thompson, Pres. & S. M.; James J. Murley, Sect. Treas.; John Saint Amour, Prod. Mgr.; Agnes Thompson, Sales; Walt Helms, Ch. Engr.; James J. Clelland, Engr.; Bob Jones, P. A.; Bob Pugsley, Meter Supt.

Associated Research, Inc.
Chicago 18, Illinois 117

Exhibiting: New Products—Model 263A Vibroground for push-button earth resistivity measurements by the 2, 3 or 4 electrode method; Model 343A soil resistivity meter measures directly in ohms per cc. in a 12 in. radius from tip of 4 ft. exploring probe; Model 250 high megohm push-button control a.c. powered covering electric insulation measurements in four ranges of 1 to 50,000 megohms; Model 267 Vibrotest to measure electrical resistance of conductive flooring such as in explosive atmospheres and hospital operating rooms; Model 244A ohmmeter accurate to 0.5 percent, compensates for internal resistance changes of batteries; Model 321 donut instrument current transformer features a large (2.5-in. diam.) opening for larger current-carrying conductors; Retractable tip prod for all high voltage test equipment. **Regular Products**—Vibrotest electric insulation resistance measuring instruments; Vibroground ground resistance measuring instruments; Hypot hypotential dielectric strength testing instrument, tachometers, phase sequence indicators, ohmmeters, limit resistance bridges, voltammeters, current transformers. Research, design and manufacture precision electrical measuring instruments.

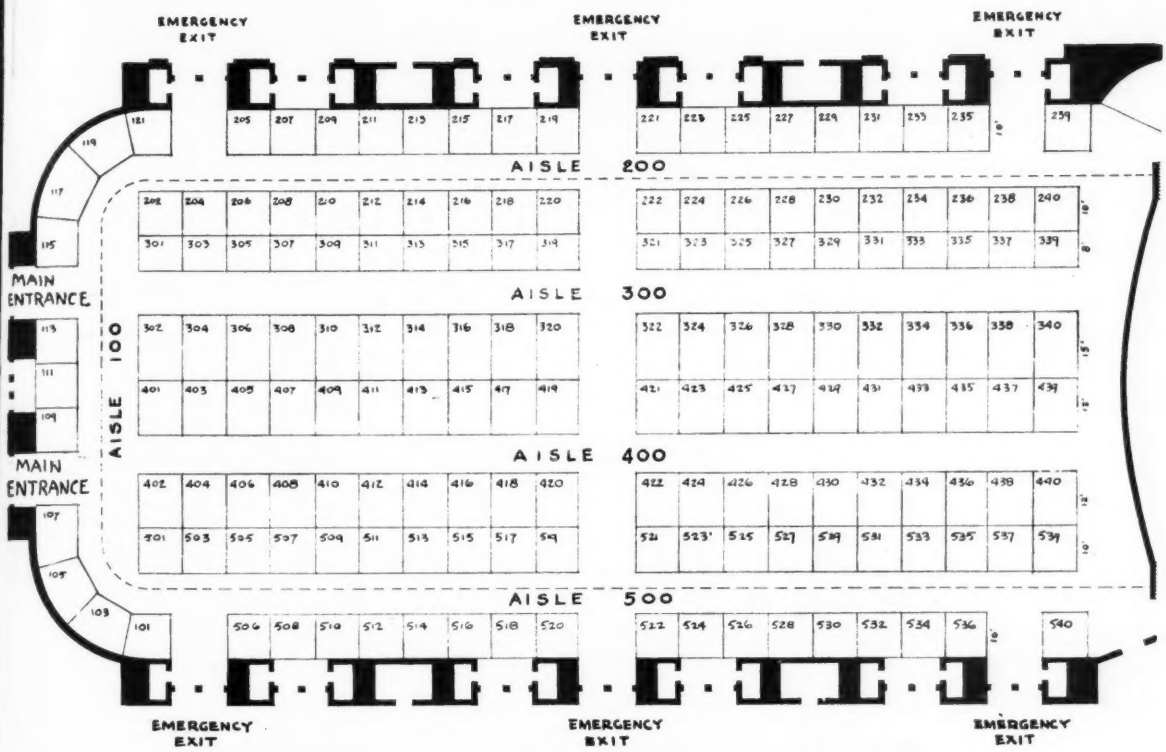
In Attendance: James F. Inman, Richard W. Inman, Robert G. Davis, Chris Safter, John Mahon.

Associated Valve and Engineering Co.
Chicago 21, Illinois 333, 335

Exhibiting: New Products—High pressure and temperature valves, 4000 psig. 1500 F., hand control or electric motor or solenoid or air cylinder, packless and packed type; High-vacuum valves in all corrosion-resisting alloys, packless design with metal bellows or metal-and-synthetic diaphragm seals, hand control or any type motor; Vacuum and pressure regulators, diaphragm type in all corrosion-resisting alloys; Vacuum breaker, brass or corrosion resisting alloys; Series 1127 Float valves, corrosion-resisting alloys, pilot-operated, pressures up to 200 psi.; Series 1125 Float switch, corrosion-resisting alloys; Combination pressure and vacuum relief valves, designed for Signal Corps, for use on transit cases; Series 1133 Needle valves, corrosion-resisting alloys, pressures up to 3000 psi; 3-way valves, corrosion resisting alloys, hand controlled, diaphragm type, motorized solenoid and solenoid air cylinder combination. **Regular Products**—Needle valves, float valves, pressure relief valves, float switches, float controls, check valves, quick opening valves, all available in corrosion resisting alloys.

In Attendance: Joseph Schubert, Pres.; Frank Schubert, Treas.; Fred H. Sklenar, Ch. Engr.; V. McCaffery, S. M.; J. Petrosius, Engr.

ARENA



MAIN EXHIBITION HALL

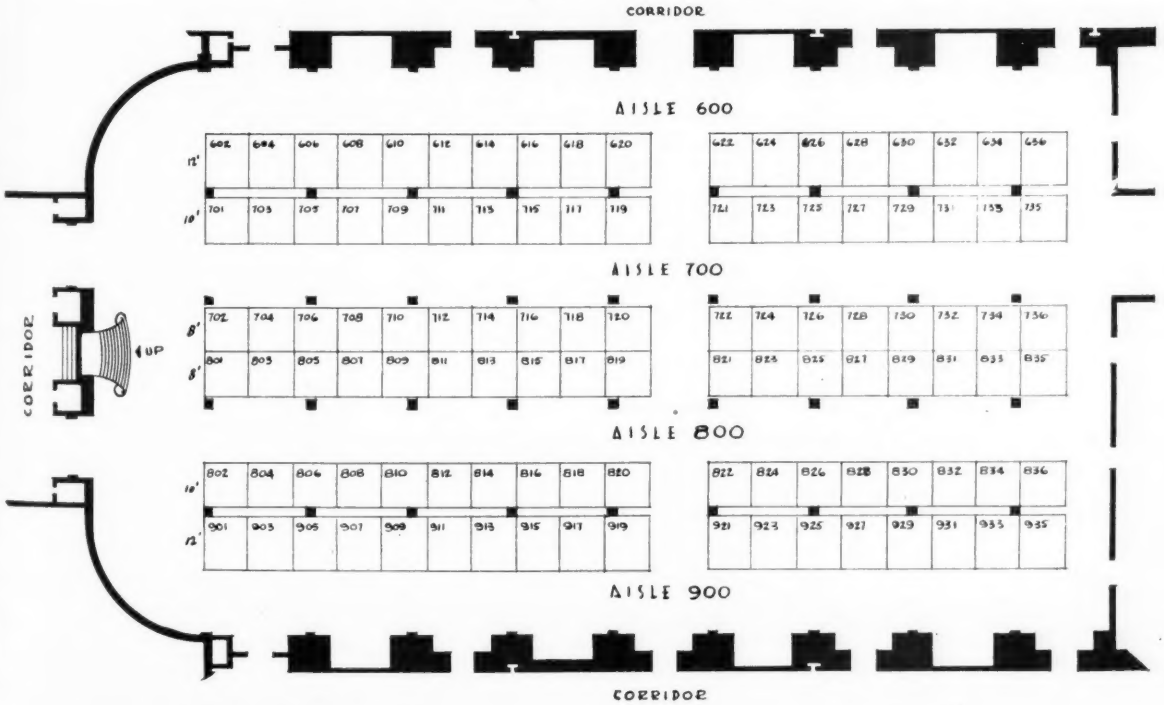


EXHIBIT HOURS: Monday (Sept. 8) ..... **3 P.M. to 10 P.M.**
Tuesday and Thursday (Sept. 9 and 11)..... **2 P.M. to 10 P.M.**
Wednesday and Friday (Sept. 10 and 12) .....**10 A.M. to 6 P.M.**

Automatic Electric Sales Corp.
Chicago 7, Illinois 103

Exhibiting: New Products—Hermetically sealed miniature rotary stepping switch for aircraft and guided missile use; Shok-Lok lever key switch incorporating positive locking vibration-proof mechanism; miniature relays hermetically sealed in glass permitting continuous observation of contacts and adjustment under operating conditions. **Regular Products**—Telephone type relays, rotary stepping switches and key switches including hermetically sealed "AN" and regular types.

In Attendance: V. E. James, Mgr. Ind. Control Equip. Sales; A. R. Tindell, Asst. Mgr. Ind. Control Equip. Sales; C. W. Rasmusen, R. E. Page, Salesman.

Automatic Switch Company
Orange, New Jersey 618

Exhibiting: New Products—Bul. 8344 high-speed heavy-duty 4-way solenoid-operated valve for severe service on applications where reliability and ruggedness are the all important factors; Midget size ¼ in. port, ¼ in. pipe, 2-way and 3-way solenoid-operated valve with time delay feature. **Regular Products**—Solenoid-operated valves, industrial type relays and contactors, remote-control switches, automatic transfer switches, specialized control panels, solenoids.

In Attendance: R. F. McCormick, Valve Sales Mgr.; A. A. Anderson, E. E. Folds, Sales Reps.

Automatic Temperature Control Company
Philadelphia 44, Pa. 532, 534

Exhibiting: New Products—Atcotran instrument system for extremely accurate measurement and control of pressure, vacuum, flow and numerous other variables utilizing electrical transmission, high sensitivity, 0.2 percent accuracy and scale lengths up to 90 in.; Duo Set timer, a dial timer of the repeat-cycle type, equipped for individually and easily setting both "on" and "off" times. **Regular Products**—Motorized valves; Electronic relays; Input controllers; Impulse counters; Electronic contactors; Vernier set timers; Cam timers; Electronic timers; Delay timers; Valves, butterfly, V-port; Atcometer.

In Attendance: I. G. Johanson, V. P.; W. W. Winters, Sales Mgr.; W. D. MacGeorge, Chief Engr.; G. G. Outerson, District Mgr., Cleveland; C. Roessler, Proj. Engr.; George J. Ebling, Sales Prom. Mgr.; Herbert Barnum, Mgr. Detroit; George Crewson, Mgr. Chicago.

Aviation Engineering Corp.
Woodside, L. I., 77, New York 731

Exhib'ting: New Products—Maximizing and minimizing temperature indicating system, electronic self-balancing bridge type instrument indicates either maximum or minimum temperature of any number of resistance bulbs using a single indicator; Capacitor type liquid quantity gages, measures conducting, non-conducting and corrosive liquids on a gravimetric basis; Capacitor type level switch, provides dependable level control for conducting, non-conducting and corrosive liquids without use of moving parts; D.c. reference voltage standard, accuracy of a standard cell obtained throughout the full range of environmental variations experienced on military aircraft; Exhaust gas thermometer operates at an accuracy of plus or minus 5 deg. C from zero to 1000 deg. C; Pressure transducers, utilize capacitance principle, are insensitive to vibration and may be mounted directly to aircraft without shockmounting, unaffected by temperature as high as 70 deg. C; Jet engine thrust indicator, an analog computer uses pressure measurements to solve an empirical formula to provide an in-flight indication of pounds of gross thrust. **Regular Products**—Capacitor type fuel quantity gage; Fuel balancing controls; Cylinder head temperature indicator; Capacitor type level switch (aircraft type.)

In Attendance: Leo. A. Weiss, Pres.; F. L. Burgess, V. P.-Sales Mgr.; R. J. Levine, Ch. Engr.; F. Meyer, Ch. Proj. Engr.; E. P. Snyder, Admin. Engr.; M. Heyert, H. Siegel, Service Engrs.; S. Solarz, Adv. Mgr.

Bacharach Industrial Instrument Company
Pittsburgh 8, Pa. 508

Exhibiting: Portable testing instruments for combustion analysis, Diesel engine tests and plant maintenance.

In Attendance: John W. Smith, Sales Dept.

Baird Associates, Inc.
Cambridge 38, Mass. 709, 711

Exhibiting: New Product—Plant Stream Analyzer, continuous automatic control with high sensitivity and discrimination wherever process stream concentration of an infrared absorbing material is a criterion.

In Attendance: S. H. Walters; J. M. Devine; H. Short; L. H. Lyon; Glen Smith; W. A. Patterson.

Baker Company
Maplewood 1, Maine 708, 710

Exhibiting: New Products—Tweezer type bearing handling tools; Torque testers for ball bearings; Ultrasonic ball bearing cleaner; Air sterilizer and conditioner. **Regular Products**—Ball bearing assembly tools; Sterilshield cabinets—dust free and germ free. Engineering consultation on handling, cleaning, testing, assembly of instrument ball bearings.

In Attendance: Arthur K. Baker, Pres.; Mrs. Arthur Baker; E. M. Baker, V. P. and Treas.; John W. MacGregor, Supt.; Robert L. Chadbourne.

Barksdale Valves
Los Angeles, Calif. 722, 821

Exhibiting: Barksdale valves; Cresent valves; Meletron pressure actuated switches.

In Attendance: L. S. Barksdale; Carl Grier; M. C. Nelson; Jim Brown.

Barnes Development Company
Lansdowne, Pa. 835

Exhibiting: New Products—Graph plotting recorder, plots graph of two variables in rectangular coordinates, rectangular charts 8½ x 11 in. **Regular Products**—Test data recorders; automatic recording bridges. Development, design and production of special electromechanical instruments, recorders and precision devices for high-volume production and testing.

In Attendance: George W. Barnes, Pres.; Freda S. Barnes, Sec.; Harry M. Heisler, Design Engr.; Marguerite Heisler, Receptionist.

Barton Instrument Corporation
Los Angeles 22, Calif. 507

Exhibiting: New Products—Model 214 pneumatic differential pressure transmitter, mechanically linked indicator, rupture-proof stainless steel bellows actuator. **Regular Products**—Model 163 indicator, Model 181 indicator, Model 200 indicator, Model 211 indicating flow switch, Model 202 recorder.

In Attendance: Claude B. Nolte, V.P.; Ben Farmer, Gus Ollos, Alex Weiss, John Collins, G. E. Flower, D. H. Abbott, N. S. Jacobs, Representatives.

Beckman Instruments, Inc.
So. Pasadena, Calif. 428, 430

Exhibiting: New Products—Special attachment for the Beckman Model DU spectrophotometer, total range now 200 to 2700 millimicrons, also provides a-c. automatic and scanning-recording spectrophotometer by addition of light-chopper assembly and lead-sulfide cell with accessories needed to amplify output to a Brown 1-second recorder, includes a percent-direct-transmittancy attachment; Recording oxygen analyzer, continuous null-balance type for the process and combustion fields utilizing direct measurement of magnetic susceptibility. **Regular Products**—Model IR-2 infrared spectrophotometer; Model R pH meter for continuous pH measurement; Flow colorimeter for measurement of liquid or gaseous streams; Portable oxygen analyzers, deflection type and precision null-balance type.

In Attendance: A. O. Beckman; R. W. Moulton; T. F. Herring; J. W. Gerrard; T. H. Barton; A. D. Herbert; T. F. Lavery; E. D. Haller.

Berkeley Scientific Division
Beckman Instruments, Inc.
Richmond, Calif. 730

Exhibiting: New Products—Series 420, presettable electronic counters with maximum counting rate of 10,000 counts/second; Model 512, electronic counters and a/megacycle signal source, elapsed time measured with accuracy and resolution of plus or minus/microsecond; Model 558, events per unit time meter, 1 megacycle, accuracy plus or minus/cycle; Series 730, preset decade plug-in unit, presettable 0 through 9 electronic counters. **Regular Products**—Model 10, 0-11 counts/sec. electronic counter; Model 410, 0-10000 counts/sec. electronic counter; Model 500, 100 microsecond resolution time interval meter; Model 510, microsecond resolution time interval meter; Series 450, photo cell and light sources; Model 550, universal counter and timer; Models 554, 556, 100 KC events per unit time meter; Series 460, tachometer pickups; Model 903, double pulse generator; Series 700, plug-in decimal counting units; Models 100, 110, 2000 radiation scalers; Model 1600, counting rate computer; Models 1800, 1810, counting rate meters; Model 3100, hand and foot monitor.

In Attendance: J. R. Dannemiller, H. B. Newman, Engrg. Reps.

James G. Biddle Company
Philadelphia 7, Pa. 808

Exhibiting: New Products—Frahm resonant-reed relay, electromechanical device responding to alternating signals having frequencies and amplitude values within specified bands; Megger low-resistance ohmmeter self-contained for field use. **Regular Products**—Megger insulation testers, ground testers and ohmmeters, Frahm tachometers and frequency meters, Jagabi centrifugal and chrometric tachometers, Jagabi rheostats, Dr. Horn tachometer.

In Attendance: Thomas Cooper, Sales Engr.; Stuart Sommer, Adv. Mgr.

J. Bishop and Company, Platinum Works
Malvern, Pa. 308

Exhibiting: New Products—Specialty parts in stainless steel. **Regular Products**—Mechanical, capillary and hypodermic stainless-steel and nickel-alloy seamless and welded tubing; platinum and platinum alloys; platinum and precious-metal catalysts.

In Attendance: E. E. Comfort, Asst. to Pres.; S. V. Whitaker, Sales Mgr.; Paul Kehoe, Dave Lunky, Earl Love, Tom Smith, Sales.

Black, Sivalls and Bryson, Inc.
Tulsa 3, Oklahoma 425, 427, 429

Exhibiting: New Products—Type 87 bellows seal diaphragm control valve provided with conventional Teflon stuffing box for additional leakage protection in event of bellows failure; Type 115 free-flow expanded-outlet angle valve with ample guiding surface for plug and for proper flushing of guide; Type 451 Climax Slocum mercury check valve for mercury type flowmeters to prevent mercury losses; Type 452 Climax Slocum automatic fluid stop for gas meters for preventing liquid accumulation in mercury pots; Type 209-5S special four-way piston type relay for applications requiring sequencing of control functions. **Regular Products**—Safety heads; Displacement type liquid level controllers; Diaphragm control valves. Relief valves; Pressure balanced control valves; Pressure controllers; Ratio relays. Consulting service.

In Attendance: Henry A. Ruysser, Jr., V. P. and Gen. Mgr. Sales; Jimmy Dvoracek, S. M. Climax Controls; J. F. Myers, S. M. Safety Heads; Austin Lyon, Sales Engr.; Al. J. Hanssen, Ch. Engr.; John Vossler, Mgr. Buffalo District; Walter Whetstone, Mgr. Philadelphia District; R. A. Cwik, Mgr. Chicago, District.

Boeing Airplane Company
Seattle 14, Wash. 628

Exhibiting: New Products—Operational servo, flexible electromechanical servomechanism for performing non-linear operations such as multiplication, division and generation of trigonometric functions in conjunction with analog computer applications. **Regular Products**—Electronic analog computer.

In Attendance: G. H. Singer, Jr., R. B. Harlan, Technical Reps.

Bowser, Inc.
Fort Wayne 2, Indiana 205

Exhibiting: Fig. 460 Xacto Meter; Fig. 445 Rotorol Meter; Photograph blow-up illustrating the Bowser precision blending system.

In Attendance: W. H. Harks, V. P. and Gen. Sales Mgr.; F. S. Ehrman, V. P. Industrial Sales; J. E. Doelling, S. M. Meter Division; H. W. Stahl, Regional Mgr. Cleveland; C. J. Egger, Asst. Reg. Mgr. Cleveland; D. F. Price, Sales Engr. Cleveland; W. A. Cartwright, Market Analyst.

Bowser Technical Refrigeration Division of Bowser, Inc.
Terryville, Conn. 207

Exhibiting: Laboratory environmental testing equipment.

In Attendance: Thomas J. Lopiccolo, V. P. Sales; Jack Shamroth, V. P. Production; Norman R. Miller, Ch. Engr.; Karl D. Klein, Sales Engr. Eastern Seaboard; R. N. Williams, Sales Engr. North Central.

Brookfield Engineering Laboratories, Inc.
Stoughton, Mass. 717

Exhibiting: Synchro-Lectric Viscometer; Counter-rotating Mixer; Helipath Stand; various accessories.

In Attendance: W. B. Brookfield, S. M.; D. W. Brookfield, Dir. of Research; R. A. Minard, Staff Rheologist.

Brooks Rotameter Company
Lansdale, Pa. 421, 423

Exhibiting: New Products—Trin-Vue sight-flow indicator for lines up to 4 in.; New series of barstock body armored rotameters with high-pressure gage glass extension for metering dan-

gerous liquids at high pressures and temperatures; High-pressure seal oil purge meter for maintaining constant flows to mechanical packing glands, etc. **Regular Products**—High-pressure lab kit rotameter; Multi-tube rotameter lab kit; Triple meter lab kit; Full-View rotameters with safety shielding; Brown Electronik for recording, controlling and integrating of flows.

In Attendance: Douglas N. Brooks, Pres.; John B. McPherson, Eastern D. S. M.; Harry A. Alsentzer, Application Engr.; Gordon D. Carnegie, Cleveland Rep.; John B. Larimore, Columbia Rep.; Donald H. Abbott, Cincinnati Rep.; H. H. Barnum, Detroit Rep.

Brush Development Company
Cleveland 14, Ohio 804, 806

Exhibiting: New Products—Model BL-954 high-gain preamplifier for voltage measurements in the microvolt range, for measurement of physiological phenomena such as electrocardiography and electroencephalography; Model BL-213 Welding Analyzer for checking resistance type welding equipment, consists of a BL-320 universal strain amplifier, a modified BL-932 DC amplifier, and a modified BL-202 dual channel oscillograph; redesigned Brush amplifiers for rack mounting. **Regular Products**—BL-103 Surface Analyzer; BL-122 Faxfilm comparator, BL-2301 level recorder; BL-1011 oscillator, BL-2105 frequency analyzer and BL-4111 microphone.

In Attendance: A. J. W. Novak, Commercial Engr. Mgr.; E. M. Hensley, H. J. Harsant, W. R. Stern, Commercial Engrs.; M. Darnovsky, Promotion-Market Research.

Buffalo Meter Company
Buffalo 14, New York 231

Exhibiting: Niagara Meters for volumetric measurement of most liquids including cold and hot water, oils, solvents, corrosive and non-corrosive chemicals. Meters are of bronze, iron, steel or stainless steel casing construction. Registers are electricontact type, vertical setback or horizontal cumulative types.

In Attendance: H. F. Barrett, S. M.; W. G. Carter, Asst. S. M.; S. E. Illes, H. Collura, Representatives.

Burgess Battery Company
Freeport, Illinois 221

Exhibiting: Complete line of dry batteries. Engineering service on dry battery problems.

In Attendance: L. D. Foust, Sales Engr.; R. Chase, Representative; L. H. Harriss, Sales Mgr.

Burling Instrument Company
South Orange, New Jersey 807

Exhibiting: New Products—Model A temperature control, smaller size unit operating on same principle of differential expansion of solids used on all Burling controls, for temperatures 30 to 300 F., sheet aluminum cover; Model B temperature control, same as Model A but with water- and vapor-tight cast aluminum case with threaded joint and gasket, for temperatures sub-zero to plus 300 F. **Regular Products**—Temperature controls for electric and pneumatic operations; Self-operating temperature controlled valves.

In Attendance: Herbert S. Burling, Pres.; H. Sherman Burling, Jr., S. M.

N. W. Calvert Company
Cleveland 14, Ohio 713

Exhibiting: Regulators for pressure, temperature, differential, back pressure and liquid level; Pump governors; Electrically controlled regulators; Desuperheaters and strainers.

In Attendance: N. W. Calvert; E. E. Miller; C. A. Hunter; W. J. Voss; E. Grafe.

Cameron Iron Works, Inc.
Houston 1, Texas 510

Exhibiting: Non-lubricated lift-plug valve. Service for pipe line measurement stations, drilling and production service, refineries, food processing, chemical plants.

In Attendance: Jack W. Harris, Asst. S. M.; I. W. McKinney, Sales Engr.

Canadian Radium & Uranium Corp.
New York 20, N. Y. 630

Exhibiting: New Products—MAPGLO, fluorescent coating for use on maps, charts and any printed matter or any designated areas which will render the coated areas clearly visible under U.V. thus eliminating the use of ordinary light. **Regular Products**—Luminous products; radioactive compounds, phosphorescent compounds, fluorescent compounds, infrared phosphors, special phosphors. Research and luminous treatment and application to all instruments and parts; Confirmation to all Government Specifications.

In Attendance: Boris Z. Gorlin, Ch. Engr.; A. J. Pregel, V. P. Engrg.; Ben Friedman, Engr. Applications; L. W. Ellin, Mgr.; Dr. P. A. Tumarkin, Ch. Chem. Charge Research.

Carboloy Dept. of General Electric Company
Detroit 32, Michigan 522, 524

Exhibiting: New Products—Carboloy thermistors, semiconductors with electrical resistance that varies rapidly with temperature changes. **Regular Products**—Carboloy Alnico permanent magnets produced by powder metallurgy in cast and sintered form. Technical assistance with problems of application and design.

In Attendance: E. L. Hubbard, Mgr. Permanent Magnet Sales; E. E. George, Mgr. Permanent Magnet Engr.; R. J. Parker, Supervisor Application & Design Engr.; J. E. Weldy, Mgr. Marketing; F. J. Staroba, Mgr. Field Sales; Wm. Baker, Mgr. East Central District; E. C. Howell, Mgr. Merchandising; J. W. Mason, Asst. Mgr. Merchandising, K. R. Beardslee, Gen. Mgr.

Case Institute of Technology
Cleveland 6, Ohio .....Stage

Exhibiting: Instrumentation; Automatic control; Servomechanisms. Literature on courses and research facilities.

In Attendance: Members of staff of Department of Mechanical Engineering.

Century Geophysical Corp.
Tulsa 10, Oklahoma 408

Exhibiting: New Products—Model 1809 Bridge control unit, provides balancing, calibrating and matching networks required for 12 channels of resistance, stress-strain measurement. **Regular Products**—Multi-channel recording oscillographs; Strain gage amplifiers; Recording galvanometers.

In Attendance: T. J. Ray, Jr., S. M.; A. D. Barnes, J. H. Black, Alex Weiss, Representatives; J. A. Stafford, Chief Engr.; Gene Robertson, Engr.

John Chatillon and Sons
New York 38, New York 215

Exhibiting: New Products—Specialized Iso-elastic precision springs; Temperature-compensated Iso-elastic springs for aeronautical field; Iso-elastic twin extension springs for computing scales for precision measurements. **Regular Products**—All types of precision springs of all materials and shapes. Engineering on all spring problems.

In Attendance: M. Gerard Fangemann, Mgr. Spring Div.; Joseph E. Gerbore, Ch. Engr. Spring Div.

Chemiquip Company
New York 29, New York 736

Exhibiting: New Products—"Mercureceiver" for preventing loss of mercury from manometers, dampens surges and pulsations and prevents incorrect readings. **Regular Products**—Porous metallic pressure snubbers.

In Attendance: Julian A. Lipman, Gen. Mgr.; Sylvia S. Lipman, Secretary.

Commercial Research Laboratories, Inc.
Detroit 3, Michigan 909, 911

Exhibiting: New Products—Cox Type 416 universal fuel nozzle test stand for precision measurement of fuel nozzle flow. **Regular Products**—Air flowmeter; Carburetor flow stand; Engine indicator; Flowmeters; Flowmeter calibrating stands; Fuel nozzle test stands; Magnetic thickness gages; Electronic equipment; Vibration recorder. Testing instruments for the automotive, aircraft and allied industries.

In Attendance: Roger A. Merritt, S. M.; Earl Scanlon, Sales Engr.; H. A. Van Hala, Cleveland Rep.; R. Yung, Detroit Rep.; P. Shannon, Chicago Rep.

Conax Corporation
Buffalo 21, New York 833

Exhibiting: New Products—Stainless steel miniature packing glands for sealing small tubes or rods; Replaceable bare-wire thermocouples for use in pressure systems provides for insertion and removal of bare thermocouple wires to systems under pressure without loss of pressure; Quick-disconnect, waterproof thermocouple assembly, designed for and used by the Atomic Energy Commission. **Regular Products**—Conax bare wire thermocouple glands; Conax stainless steel packing glands; Conax stainless steel split follower packing gland. Engineering service in special thermocouple or pressure-sealing problems.

In Attendance: M. W. Connell, S. M.; J. Considine.

Conoflow Corp.
Philadelphia 3, Pa. 109, 111, 113

Exhibiting: New Products—Cono Series LB control valves, split body valve with renewable seat ring featuring exclusive milled groove design of value plug, powered by new cylinder conomotor; Rotomotor, pneumatic throttling operator in which a threaded stem is positioned by means of a reversible motor driven through a worm type gear train. **Regular Products**—Airpack; Panels; Packaged purge assemblies; Precision pressure regulators; "EB" current controllers; Pressure transmitters; Cylinder Conomotors.

In Attendance: R. B. Werey, Pres.; M. Mark Watkins, V. P. & Treas.; John C. Koch, V. P. & Sales Mgr.; Edward K. Graham, Jr., Chief Engr.; Charles P. Boyd, William J. Leighton, James B. Madison, Sales Engrs.

Consolidated Engineering Corp.
Pasadena 8, Calif. 222, 224, 226

Exhibiting: New Products—SADIC system, Model 34-101, 4-channel instrument for direct conversion of analog signals of 1 to 64 millivolts to digital values with 0-1 percent accuracy, used with strain gages, thermocouples, etc. **Regular Products**—Recording oscillographs; Recording measurement systems; Transducers; Vibration meters; Leak detector; Titrilog (sulfur recorder). Mass spectrometer analytical laboratories for chemical analysis and isotope-ratio assays.

In Attendance: R. H. Nelson, Frank Shaw, Eugene Moscaret, Dane Waltz, J. J. McDonald, C. J. Underwood, W. J. Beagan, C. C. Snider, R. L. Smallman, Director, Tech. Services, Electro Mechanical; H. F. Wiley, Director, Tech. Services, Chemical; Geo. H. West, Director of Advertising; Richard Baird, Staff Asst. Adver-Field Engineers; W. H. Ruby, Mgr. Field Engrs.; tising.

Continental Equipment Company
Coraopolis, Penna. 517, 519

Exhibiting: Manual and automatically controlled butterfly valves.

In Attendance: Arthur M. Capper, John D. Hantz, Charles A. Dally, William F. Hartmann, Michael Prestia.

Cook Electric Company
Chicago 14, Illinois 802

Exhibiting: New Products—Cook Tarrytron timed delay relay, hermetically sealed, factory adjustable from 0.1 to 1 second, incorporating adjustable rockshaft motion, especially adaptable to missile, Jato and Jet aircraft applications; Cook Bantam aircraft contactor, adaptable for 20-50 ampere inductive 28v.dc. or 115v.ac. switching lock, cubic displacement 6.5 cu. in., weight 10 oz., filled with inert gas. **Regular Products**—Relay, hermetically sealed, miniature, 400 cycle; Time delays, thermal and mechanical; Pressure switches, hermetically sealed, vacuum, low and high pressure; Bellows, instrument type. Design and development of basic applied research in nuclear physics, upper air studies and radar.

In Attendance: John Larsen, Roy Herter, Sales Engrs.; Charlie Flubacker, Devel. Engr.; C. A. Robinson, District Representative.

R. W. Cramer Company
Centerbrook, Conn. 526, 528

Exhibiting: New Products—Reclosing relay, automatically tests for continuity of a fault for a given number of times at spaced intervals; Hermetically-sealed time delay relay with or without controlled reset; Precision time totalizer for measuring and indicating precise time intervals. **Regular Products**—Automatic electrical timing devices and miniature synchronous motors.

In Attendance: F. R. Brophy, V. P.; H. B. Goss, H. E. Harris, Sales Engrs.; E. E. Bolds, A. A. Anderson, R. O. Sords, G. T. Ray, T. F. Musgrave, L. Levar, Sales Reps.

Crawford Fitting Company
Cleveland 10, Ohio 432

Exhibiting: New Products—Instrument air valve, available with Swagelok tube fitting ends so that pipe thread can be eliminated. **Regular Products**—Swagelok tube fittings.

In Attendance: Fred A. Lennon, Pres.; E. E. Alto, Gen. Mgr.; Shelby L. Jones, R. S. Crum, E. Tierney, C. M. McKinlay, Jr., C. E. Ament, Ben Fogleman, Distributors.

Daniel Orifice Fitting Company
Los Angeles 23, Calif. 407, 409

Exhibiting: New Products—Needle valves, stainless steel, employing "O" ring principle; Steel meter leveling saddlers; Simplex orifice plate holders. **Regular Products**—Senior type orifice fitting; Junior type orifice fitting; Piston type check valve; Straightening vanes; Orifice plates; Seal pots; Fabricated meter runs; Meter manifold piping.

In Attendance: W. A. Griffin, V. P.; John Whalen, Ch. Engr.; J. V. Moore, Asst. Sales Mgr.; Ralph Clemons, Sales.

J. R. Dannemiller Associates
Cleveland 21, Ohio 730

Exhibiting: New Products—Series 420, presettable electronic counters with maximum counting rate of 10,000 counts/second; Model 512, electronic counters and a/megacycle signal source, elapsed time measured with accuracy and resolution of plus or minus/microsecond; Model 558, events per unit time meter 1 megacycle, accuracy plus or minus/cycle; Series 730; preset decade plug-in unit, presettable 0 through 9 electronic counters. **Regular Products**—Model 10, 0-11 counts/sec. electronic counter; Model 410, 0-1000 counts/sec. electronic counter; Model 500, 100 microsecond resolution time interval meter; Model 510, microsecond resolution time interval meter; Series 450, photo cell and light sources; Model 550, universal counter and timer; Models 554, 556, 100 KC events per unit time meter; Series 460, tachometer pickups; Model 903, double pulse generator; Series 700, plug-in decimal counting units; Models 100, 110, 2000 radiation scalers; Model 1600, counting rate computer; Models 1800, 1810, counting rate meters; Model 3100, hand and foot monitor.

In Attendance: J. R. Dannemiller, H. B. Newman.

Daven Company
Newark 4, New Jersey 329

Exhibiting: New Products—Precision wire wound resistors, miniature types; Rotary tap switches; Type 170A vacuum-tube voltmeter, 0-250000 cycles; Attenuators, audio, video and r.f.; Decade resistance boxes; Volume level indicators. **Regular Products**—Precision wire wound resistors; Attenuators; Rotary tap switches; Transmission measuring sets; Voltage dividers; Voltmeters; Frequency meters; Resistance decade boxes; Equalizers; Oscillators. Electrical and electronic engineering, design and development.

In Attendance: E. L. Grayson, S. M.; K. K. Garrison, Sales Engr.

Davis Instruments
Newark 4, New Jersey 101

Exhibiting: New Products—Redesigned combustible gas alarm system incorporating easy maintenance and service accessibility; Semi-portable self-contained continuous toxic gas analyzer. **Regular Products**—Portable and continuous gas analysis instruments. Design and manufacture of gas analysis and process control instrumentation to meet specific requirements utilizing three basic principles: catalytic combustion, thermal conductivity and electrical conductivity.

In Attendance: F. Rutledge Davis, Chairman of the Board; F. Taylor, Jr., V. P.; A. E. Lawson, Gen. Mgr.; Chas. Devrishian, Engineering Dept.

Deltavis Company
Soleure, Switzerland 809

Exhibiting: Automatic screw machine products, high accuracy to user's specifications.

In Attendance: Dr. Walter P. Reinert.

De Zurik Shower Company
Sartell, Minn. 212

Exhibiting: De Zurick easy-operating plug valves both manual and automatically operated.

In Attendance: Dave De Zurick, Pres.; Bill O'Connell, Sales Engr.

F. W. Dwyer Manufacturing Company
Chicago 12, Illinois 714

Exhibiting: New Products—Slack tube manometer, flexible U-tube manometers to 120 in. length. **Regular Products**—Draft gages; Manometers; Pitot tubes; Gas analyzers; Pressure switches; Flowmeters; Air filter gages, etc.

In Attendance: F. W. Dwyer, Pres.; J. G. Dwyer, Sec.

Eagle Signal Corporation
Moline, Illinois 228

Exhibiting: New Products—Motors, small synchronous and small synchronous reversing; Hagen motor designed for industrial heavy-duty service, 48 inch-ounce starting torque at 1 rpm, available in all voltages and frequencies. **Regular Products**—Timers reset—Microflex, Cyclflex, Multiflex, Polyflex, Timoflex, Controlflex, Manualflex, Duraflex; Timers repeat cycle—Flexopulse, Polypulse, Interrupter, HQS213 series reversing; Counters, predetermined—Microflex.

In Attendance: E. F. Havey, V. P. in Charge of Industrial Sales; A. R. Virgien, J. D. Marotta, Warren Hallock, W. A. Woehr, Sales Engrs.; Vince Blecker, Ass't. Sales Mgr.

Eastman Kodak Company
Rochester 4, New York 614

Exhibiting: Linagraph films and papers for instrument recording; Kodak high-speed camera with oscillographic attachment.

In Attendance: A. E. McCoy, Jr., M. I. Sandell, Sales.

Edin Company
Worcester 8, Mass. 405

Exhibiting: D-c. amplifiers; A-c. amplifiers; Ink-writing galvanometers; Oscillograph recorders.

In Attendance: Murray W. Edinburg, Pres.; Neil R. Seitzman, S. M.

Thomas A. Edison, Inc.
Instrument Division
West Orange, New Jersey 718

Exhibiting: New Products—Miniature timing relay with initial delays from 5 to 120 seconds, ambient compensated, meets shock and vibration requirements for aircraft application, sealed in glass, weight 0.5 oz. **Regular Products**—Timing relays; Thermostats; Sensitive d-c. relays; Temperature monitors; Resistance bulbs, electrical; Fire detection systems; Temperature indicating and alarm systems; Glow plugs; Temperature indicators (aircraft). Engineering development of temperature alarm systems.

In Attendance: Albert B. Poe, Adv. Mgr.; R. J. Sentenac, Dayton Rep.; C. J. McVey, Jr., Chicago Rep.; R. N. Gierse, S. M.; J. J. Dietz, Ch. Engr.; H. E. Smith, Market Research.

Electric Indicator Company
Springdale, Conn. 836

Exhibiting: Precision sub-fractional horsepower instrument type motors and generators.

In Attendance: L. J. Hudson, F. R. Thompson, Owners; G. E. Monchamp, Ch. Engr.; A. E. La Lime, Design Engr.; John Riker, P. A.; Wallace Curtis, Tech. Engr.; A. Markelon, Ch. Draftsman.

Emmett Machine and Manufacturing, Inc.
Akron 14, Ohio 622

Exhibiting: New Products—Type E 304 robotron; Merit electric operated valves. **Regular Products**—Merit low pressure and hydraulic diaphragm valves; Robotron cycle controllers; Robotron control centers; Mastertrol control centers; Merit pressure and temperature controls. Automatic control engineering.

In Attendance: E. W. Ellis, Pres.; E. B. Sutherland, V. P.; S. Proctor, L. V. Parsson, Reps.

Esterline-Angus Company
Indianapolis 6, Indiana 712

Exhibiting: Electrical recording instruments; Tachometer generator; Operation (time) recorder.

In Attendance: Chester M. Poor, Adv. Mgr.; L. H. Waldrip, Myron Blankenburg, Engrg. Reps.; R. J. Kryter, S. M.; D. J. Angus, Pres.

Falstrom Company
Passaic, New Jersey 720

Exhibiting: New Products—Deep wing panel, a self-supporting control board can be bolted or lagged to the floor, side wings protect equipment. **Regular Products**—Instrument and control panelboards made of steel, aluminum or stainless steel; Housings; Enclosures; Cases fabricated to specification; Consoles; Boiler boards; Turbine boards; Gage boards. Design, engineering and fabrication for custom instrument control panelboards.

In Attendance: Richard E. Hill, Charge of Exhibit; William Ricker, Henry F. Johnson, Sales Engrs.

Farris Engineering Corp.
Palisades Park,
New Jersey 209, 211, 213

Exhibiting: New Products—Farriseal and Balanseal bellows construction for back pressure and corrosive services, protecting guides, spring and spring chamber at all times. **Regular Products**—Spring-loaded safety relief valves.

In Attendance: V. W. Farris, Pres.; W. J. Alberti, R. V. Biamonte, K. Grosse, Sales.

Farris Flexible Valve Corp.
Palisades Park,
New Jersey 209, 211, 213

Exhibiting: New Products—Non-plugging, corrosion and abrasion-resistant rubber valves, full pipe capacity, no seats, weirs, disks, low pressure drop across valve, from 0.5 to 12 in. **Regular Products**—Type 7100 handwheel-operated rubber valve 0.5 to 2.5 in.; Type 7200 handwheel operated rubber valve 1 to 12 in.; Type 7300 diaphragm air operated valve 1 to 10 in. Engineering valve service for any industry where corrosion, erosion, abrasion or plugging exists.

In Attendance: R. Vonder Lieth, Sales.

Farris Stacon Corporation
Palisades Park,
New Jersey 209, 211, 213

Exhibiting: New Products—Self-operating temperature regulators direct and reserve acting, 1 deg. F. control accuracy, packless construction and design simplicity. **Regular Products**—Self-operating temperature regulators. Engineering service for process and general temperature control of liquids.

In Attendance: E. Groth, Jr., Sales.

Fenwal, Incorporated
Ashland, Mass. 230, 232

Exhibiting: New Products—Miniature Thermoswitch unit, smaller than a stack of five nickels, weight 0.25 oz., carries 300 watts with accurate control; Rate-of-rise Thermoswitch temperature control capable of limiting or detecting rate of temperature rise; Detect-a-flo control for detecting or controlling flow rate of liquid or gaseous fluids, rated at 500 watts-115 volt a.c., hermetically sealed; Thermoswitch unit in plastic, sealed in transparent moisture-proof plastic bag for applications with severe moisture conditions. **Regular Products**—Thermoswitch thermostats, Detect-a-fire fire detectors. Temperature control engineers.

In Attendance: C. J. Robinson, S. M.; J. J. Goode, T. R. Eilenberg, Sales Engrs.

Fielden Instrument Division
Robertshaw-Fulton Controls Company
Philadelphia 33, Pa. 233, 235

Exhibiting: New Products—Electronic recorder employing the Fielden follower system, featuring a servo-operated pen to record any signal input to a standard d'Arsonval movement; Electronic capacity-operated continuous level indicator or recorder for use with liquid or solid, conducting or non-conducting, centralized gaging meters may be installed remote from transmitting element; Resistance bulb thermometer recorder based on self-balancing bridge principle; Four-point pen resistance bulb thermometer recorder; Proximity meter, employing a capacitance system particularly useful for measuring extremely small mechanical displacements. **Regular Products**—Drimeter, continuous moisture measurement for textile industry; Automatic control for Drimeter; Tektor level switches.

In Attendance: R. V. Coles, V.P.; D. S. Bunch, Sales Mgr.; L. C. Connolly, Sales Engr.; L. E. Cuckler, Engineering Mgr.; H. A. Riester, C. O'Lone, Devel. Engrs.

Fischer and Porter Company
Hatboro, Pa. 202, 204, 206

Exhibiting: New Products—P-4 Pneumatrol, all-purpose controller, point-of-measurement and single or dual case-mounted, with new features to cover ratio control, fully adjustable pneumatic set and master set multiple-element control; Resotronic continuous quantitative analyzer, method based upon r.f. absorption phenomenon; Tri-Flat Flowrator meter predictability program for low flow-rate meters; Ratogate, wide-range slurry valve; Purgerator control panel featuring new purge meter and new differential regulator; High-speed totalizer with oil-immersed clutch and new magnetic clutch roller lock; Series 700 Flowrator meter, semi-enclosed with two-sided and four-sided visibility; Pneumatic transmitter featuring flat calibration springs, temperature compensation, unique pilot, high-capacity P-4 relay; Manomax manometer, 600-in. scale indicator, accuracy of 0.01 percent, manual and servo-rebalanced, for absolute pressure and single and differential pressure applications; Minicator vertical drum-scale miniatures for graphic panels, with pneumatic or electric relays and illuminated color bands; Temperature-compensated Viscorator featuring "auto-sampler" sampling rate control; Magnabond stainless steel mercury manometers featuring temperature compensation; Fig. 54-OLX precise flow-rate transmitter-receiver system. **Regular Products**—Valvrator diaphragm valve; Feedrator chemical feeder; Magnasight all-metal sight flow indicator; Ratosight sight flow indicator; Kinetic manometers: Ratosleeve high-capacity area meter; Cable and drum levelrator; Flowrate meters; Ratochlor chlorinator; Temperature and pressure instruments for general requirements.

In Attendance: Kermit Fischer, Pres.; John O. Larson, Exec. V. P.; Philip E. Sellers, S. M.; Nathaniel Brewer, Res. Dir.; Edmund Haigler, Herbert Clarke, Louis Ollivier, Jack Boonshaft, Res. Engrs.; Henry Lorence, A. M.; Henry Holden, Ser. Mgr.; Douglas Dismukes, Mgr. Fluids Engg.; Louis Aricson, Mgr.; Edward Muhleisen, S. Engr.; Herman Kockritz, Dist. Mgr. Atlanta, Albert Beehler, Jr., Dist. Mgr. Baltimore-Washington; Ralph Klucken, Dist. Mgr. Boston; P. T. Charest, Dist. Mgr. Buffalo; Charles Levis, Field Engr. Buffalo; Robert E. Johnson, Dist. Mgr. Chicago; Edward Janis, Harry Sieg, Field Engrs. Chicago; Robert L. Rice, Dist. Mgr. Cincinnati; George W. Gard, Dist. Mgr. Cleveland; Fred Alderman, Richard

Baker, Field Engrs. Cleveland; Roland M. Waters, Dist. Mgr. Detroit; James Haskett, Field Engr. Detroit; Carl J. Smedsrud, Dist. Mgr. Milwaukee; Jerome J. Schwab, Engr. Rep. Minn.-St. Paul; George H. Birchall, Jr., Div. Mgr. New York; Bernard Ungerleider, Jack D. Morrison, Field Engrs. New York; Seymour Blechman, Div. Mgr. Philadelphia; Charles Delgado, Eugene R. Klotz, Horace F. Richter, Field Engrs. Philadelphia; Harvey Krouse, Dist. Mgr. Pittsburgh; Robert Mingle, Field Engr. Pittsburgh; G. Douglas Zimmerman, Mgr. Toronto; Don McCammon, Gerald Crossman, Jr., Field Engrs. Toronto; George Rice, Dist. Engr. Montreal; Edmund Lehmann, Field Engr. Montreal.

Fisher Governor Company
Marshalltown, Iowa 314, 316, 318

Exhibiting: New Products—Liquid level proportional receiver controller; Liquid level reset action receiver controller. **Regular Products**—Diaphragm-motor valves; Pressure pilots; Liquid level controllers; Pressure regulators; Positioners; Manual operated handwheel topworks; Valve body structures; Inner valves.

In Attendance: P. A. Elfers, V. P.; Lyle E. Eige, Asst. S. M.; G. F. Brockett, Ch. Sales Engr.; Harold Kinney, W. D. Ehrke, John Schultz, R. G. Read, Norman Hatter, Sales Engrs.

Foster Engineering Company
Union, New Jersey 903, 905

Exhibiting: New Products—Flow tube, new primary element for the measurement, regulation and control of fluid flow. **Regular Products**—Pressure regulators; Relief and back pressure valves; Cushion check valves; Altitude valves; Fan engine regulators; Pump governors; Temperature regulators; Float and lever balanced valves; Non-return valves; Strainers; Sirens; Safety valves; Vacuum regulators or breakers; Flow tubes.

In Attendance: H. J. Fortier, V. P. Sales; H. Rodewald, V. P. & Gen. Mgr.; V. Gentile, Consultant; G. Bauer, V. J. Luby, N. L. A. Martucci, Sales Dept.

Fulton Sylphon Division
Robertshaw-Fulton Controls Company
Knoxville 4, Tenn. 416, 418, 420

Exhibiting: New Products—Temperature regulators Numbers 999 and 998 for control of industrial processes, etc.; Steam-water mixer for source of hot water for industrial applications; Packless valves; Shaft seals. **Regular Products**—Temperature controls; Pressure controls; Safety controls for Diesel engines, etc.; Hot-cold water mixers; Packless valves; Bellows and bellow assemblies.

In Attendance: E. D. Rogers, Adv. & Sales Pro. Mgr.; L. S. Dysart, S. M., Controls Div.; D. D. Gordon, Sales Div., Controls; M. G. Calhoun, Sales Div., Bellows Assemblies.

Garwin, Inc.
Wichita, Kansas 630

Exhibiting: Engineered applications of instruments.

In Attendance: James Garufo.

General Electric Company
West Lynn, Mass. 422, 424

Exhibiting: New Products—Differential voltage indicator capable of measuring a voltage from 0.001-30 volts of two input voltages ranging from 1-400 volts, provided they do not differ by more than 300:1; Tachometer kit for production supervisors consisting of a tachometer generator, indicator, switchboard-type recorder and, if needed, a web-break detector; G-E hand pyrometer for quick temperature checks, has two scale ranges 0-500 F. and 0-1500 F., available with flexible or rigid extension arms and three interchangeable tips. **Regular Products**—Oscillograph (type PM-18); Photoelectric recorder; Photovoltaic cells; Hook-on meters (AK-1, 2, 3); Radiation monitor; Lightbeam vibration indicator; Gauss meter; Industrial tachometer system; Zahn viscosimeter; Current limited high-potential tester; Surface roughness scales; Recording vibrometer; Hand tachometer; Thermocouple vacuum gage; Thermocouple potentiometer; Thermocouple pyrometer; Resistance thermometers.

In Attendance: J. B. Thompson, Group Leader, Ind. Insts.; S. B. Geddings, Ind. Insts.; A. B. March, Lab. Insts.; H. S. Day, Mgr. Specialty Inst. Sales; G. W. Engler, S. R. Sulis, H. W. Kuhn, Sales Engrs.; N. Gildersleeve, Section Leader, Process Insts.

General Mills, Inc.
Aeronautical Research Laboratories
Minneapolis 13, Minn. 119

Exhibiting: MOPA altitude telemetering transmitter, indicates altitude by the carrier frequency shift method, a diaphragm assembly actuates a variable capacitor for shifting frequency; Coded altitude telemetering system, transforms altitude information into International code signals, used in conjunction with a multichannel transmitter for optimum radio propagation; Micrometer oscillator, used in the 2-Mc. range as a beat frequency oscillator in the frequency shift radio telemetering system, a micrometer adjustment shifts the beat frequency one cycle per second per thousandth inch micrometer change. Services: research and development in the fields of instrumentation and control.

In Attendance: G. O. Haglund, Ass't. Director; D. J. Owen, Contracts Mgr.; M. J. Harpole, Head, Electrical Section; P. A. Christopherson, Head, Mechanical Section; K. C. Coon, Ass't. Head, Electrical Section; P. Van Krevelen, Proj. Engr.

G. M. Giannini and Company
Pasadena 1, Calif.—East Orange, New Jersey 825

Exhibiting: New Products—Gangpot, ganged potentiometer with separate phasing control for each coil, resistance 2000 to 300,000 ohms linear or functional outputs. **Regular Products**—Potentiometers, accelerometers, gyros, aeroheads, pressure instruments, stepping positioners.

In Attendance: K. Y. Rogers, V. P.; C. F. Sardou, Ch. Engr., Airborne Equip.; Paul Oling, Mfg. Mgr.; Luce, Brierly, Davis, Ryan, Sales Engrs.; Tom Moule, S. M.; J. W. Bodnar, Mgr. Potentiometer Sales; Marshall Klein, Mgr. Commercial Aircraft Sales.

Goodyear Aircraft Corporation
Akron 15, Ohio 933, 935

Exhibiting: GEDA Model L3 electronic differential analyzer, for rapid design, analysis and testing of automatic controls and other dynamic systems.

In Attendance: C. D. Morrill, Group Leader, J. A. Rudolph, C. L. Wolfe, Engrs.; H. P. Partenheimer, Contract Administrator.

Gotham Instruments
Division American Machine and Metals, Inc.
Sellersville, Pa. 721, 723

Exhibiting: New Products—Sand Mixer controller, measures temperature of sand and amount of water necessary for mix after measuring initial moisture content; Transmitter, using standard interchangeable measuring elements, standard bellows, standard movements and relay, transmits pneumatically with 3-to-15-psi. output, 6-in. and 9-in. case; Adjustable angle dial thermometer, standard ranges, stem and connections, adjustable in any angle in any plane, mercury, vapor or gas filled, sizes 3½, 4½, 6 and 8½ in.; Adjustable angle industrial thermometer, same features as adjustable dial thermometer. Sizes 7, 9 and 12 in. **Regular Products**—Recorders, controllers for pressure, temperature and time illustrating convetrible features, sizes 6, 9, 12 in.; Program controllers for temperature and pressure vesus time; Dial themometers, size 3½, 4½, 6 and 8½ in.; Industrial thermometers, size 5, 7, 9 and 12 in.

In Attendance: I. N. Becker, V. P. & Gen. Mgr.; A. E. Le Van, Dir. of Sales & Engrs.; C. A. Frank, Jr., Gen. Sales Mgr.; C. H. Fluck, Ass't. Gen. Sales Mgr.; W. J. Halpern, Gen. Mgr.; R. Hammerschlag, Sales Mgr.; S. W. Nyce, Fact. Rep.; M. W. Truesdell, Cleveland Dist. Mgr.; D. R. Laminan, Cleveland Sales Rep.

Gow-Mac Instrument Company
Newark 5, New Jersey 530

Exhibiting: New Products—Gas Master, portable indicating instrument for quantitative studies, double-mass, double-pass research-quality cell-unit, 0-100 divisions galvanometer with current check position and quick calibrating varesistor, optional recorder connection. **Regular Products**—Ever-tite thermal conductivity gas-sensing elements; Remote current-control unit, with milliammeter and cell zero adjustment. Development of special gas analysis instruments for the armed services.

In Attendance: James L. McFadden, Pres.; R. D. Richardson, Miss Jean L. McFadden, Sales Reps.

Grayhill
Chicago 24, Illinois 907

Exhibiting: New Products—Stock of small molded parts for the Electronic Lab. such as crystal holder, coil forms, stand-offs, terminal boards; Series 23 push button switch, 1/10 amp. at 115 v.ac. non-inductive; Insulated test clip No. 16-1 and No. 16-2. **Regular Products**—No. 5000 miniature rotary tap switch; No. 12 series same as No. 23 for Government application; No. 400 push button switch normally open or normally closed; No. 2200 snap-action switch, normally open or normally closed; No. 2-0 panel mount test clip. Molded parts to order at low tool charge and low price-part price.

In Attendance: Ralph M. Hill, Don Brown.

Green Instrument Company
Cambridge 39, Mass. 818

Exhibiting: New Products—Pantograph engraver for instrument panels up to 19 in. in height by any length. **Regular Products**—Green engraver; Green cutter grinder; Rotary tables; Self-centering vises; Clamping fixtures. Design and construction of special engraving production equipment.

In Attendance: Edwin T. Green, Pres.; W. Frank Fullerton, S. M.; Lynd F. Tillyer, Prod. Mgr.; Anthony R. Satullo, Howard N. Heasley, Sales Engrs.

Hammel-Dahl Company
Warwick, Rhode Island 501, 503

Exhibiting: New Products—Self-draining packless control valve; Back-seated tight shutoff control valve; Special offset-connection control valve for simplification of process piping; Miniaturized control valve for hazardous applications. **Regular Products**—Series 3000 control valves; Venturiflo angle valve; Spline plug microflow valve.

In Attendance: Edward T. Dahl, Pres.; John O. Tragard, V. P.; Maurice MacDonald, V. P.; John Curran, Design Engr.; Otto Kneisel, Asst. to Ch. Engr.; David Colner, Assc. Engr.; Robert Carter, Application Engr.; Harold Miller, Mgr. N. Y.; John Charsha, Mgr. Wilmington; Wayne Farley, Mgr. Pittsburgh.

Hankison Corporation
Pittsburgh 16, Pa. 515

Exhibiting: New Products—Chemical feeder for corrosive fluids, combines tank and feeder in one unit, no moving parts, constant head controls rate of flow. **Regular Products**—Model A-100 Condensifilter; Model B-30 Condensifilter; Recirculator.

In Attendance: P. M. Hankison, Pres.; L. E. Hankison, Consulting Engr.; D. K. Bice, Sales Mgr.; F. D. DeLeo, Prod. Mgr.; M. C. Larkin, O. R. Lawrence, R. D. Travers, H. A. Reed, Sales Reps.

A. W. Haydon Company
Waterbury, Conn. 505

Exhibiting: New Products—400 cycle ac. synchronous timing motor and timing devices delayed and instantaneous reset time delay relays. **Regular Products**—Ac. and dc. time delay relays repeat cycle timers; Chronometric governed dc. motors.

In Attendance: A. W. Haydon, Pres.; E. A. Diemand, V. P.; Fred Hoffman, John Coulombe, Sales Engrs.

Hays Corporation
Michigan City, Indiana 238, 240

Exhibiting: New Products—Low differential flowmeter, measures air flow, gas flow or air flow-gas flow ratio; Remote low-pressure gage for both electric and pneumatic transmission; Miniature vertical scale gages for electric and pneumatic transmission. **Regular Products**—O_2 and CO_2 electronic analyzers and recorders; Draft recorder and indicator; Pressure controller; Positive displacement flow indicator and controller; Console panel; Hays-Penn electric flowmeter.

In Attendance: Phil Sprague, Sr., Pres.; Phil Sprague, Jr., Exec. V. P.; Shirl Rudolph, V. P. Sales; William Pugsley, V. P. Engrg.; Paul Le Boeuf, Adv. Mgr., Orval Riggs, Mgr. Application Engrg.; Jack Tipton, Ch. Project Engr.; Clarence Miller, Project Engr.

Helicoid Gage Division
American Chain and Cable Company
Bridgeport 2, Conn. 326

Exhibiting: Helicoid gages; Chemical gages; Read vapor test; Illuminated dial; Pneumatic transmitter.

In Attendance: V. E. Lysaght, S. M.; E. C. Grauel, Engr.; Jack Morrison, Products Mgr.

Herschede Hall Clock Company
Cincinnati 6, Ohio 716

Exhibiting: New Products—Three fire control optical instruments; Eight assorted timing de-

vices. **Regular Products**—Three models of parking meters; Various types of clock movements.

In Attendance: Richard L. Herschede, John G. Jolly, Robert H. Herschede.

Hickok Electrical Instrument Co.
Cleveland 8, Ohio 107

Exhibiting: New Products—Ruggedized meters; Cathode-ray oscilloscopes. **Regular Products**—Electrical indicating instruments and electronic measuring equipment.

In Attendance: H. D. Hickok, Jr., Pres., H. D. Johnson, S. M.; J. M. Landfear, G. H. Harbaugh, Field Engrs.

Hills McCanna Company
Chicago 18, Illinois 604

Exhibiting: Diaphragm valves; Chemical proportioning pumps; Forced feed lubricators.

In Attendance: R. T. Kidde, Gen. S. M.; R. McFarland, Tech. Dir.; V. M. Barber.

Hoke, Inc.
Englewood, New Jersey 732

Exhibiting: New Products—Check valves "O" ring seal, positive seal on flow reversal, low pressure drop, "O" ring seat backed by metal; Toggle valves, quick opening on-off type, suitable for pressure or vacuum; Flo-gages, variable-area meters; Panel-mounting needle valves; majority of Hoke forged brass and stainless steel needle valves available for direct panel mounting; Reducing valves reduce pressures as high as 4500 psi to range 0 to 4000 psi, available with 5000-psi pressure gages, dome type design utilizing "O" ring sealed needle valves. **Regular Products**—Pressure reducing valves (gas); Needle valves (brass and stainless); Vacuum valves (bellows and diaphragm types); Flo-gages; Toggle valves; Blow torches; Check valves.

In Attendance: W. O. Teeters, Pres.; D. B. Salmon, V. P.; D. A. Salmon, Engr.; R. O. MacLallen.

Imperial Brass Manufacturing Company
Chicago 7, Illinois 509, 511

Exhibiting: New Products—No. 500-F Rol-air flaring tool; Nos. 437-F and 537-F 37-degree flaring tools for standard 37-deg. flare on steel, copper or aluminum tubing; No. 270-F gear-type tube bender; 37-deg. steel flared tube fittings; Tools for flaring, bending, cutting and deburring stainless steel tubing. **Regular Products**—Flared, compression, Hi-duty, inverted flared and flex brass pipe; Aluminum Hi-duty and steel Ermeto fittings; Complete line of tube benders, tube cutters and flaring tools for all tubing applications.

In Attendance: C. H. Benson, V. P.; F. McNellis, Jr., V.P.; E. F. Todd, Adv. Mgr.; Keller Waugh, M. Mitchell, Sales Reps.

Industrial Electronics, Inc.
Detroit 10, Michigan 816

Exhibiting: New Products—Myke-A-Trol electronic control system for automatic machinery control, gaging, sorting, fatigue testing, counting and indication of peak strains; Automatic sorting machine for use with the Myke-A-Trol to sort into three size groups, those parts held to tolerances plus or minus 0.1 in. to 10 microinches; Four-channel balance box, provides balancing network and switching up to four strain gage bridges or differential transformers. **Regular Products**—Model 129C Dyna-Myke; Model 144 Dyna-Meter; Model 128 Uni-Bridge; Model 134 Cali-Bridge; Model 132 Cali-Power (AC); Model 145 Cali-Power (DC); Type 100B Gage Head; Model 166 Control Box; Model 172 Selector Switch.

In Attendance: J. W. Head, Pres.; T. R. Scothorn, Ch. Engr.; A. Woehrlen, S. M.

Industrial Engineering Corp.
Louisville, Ky. 822, 824

Exhibiting: New Products—Package instrument panels, completely piped and wired; Test equipment for ful-automatic or semi-automatic quality control testing of mechanical devices; Electronic and electrical devices for the measurement of physical and chemical properties of materials. **Regular Products**—Design and manufacture of electrical, electronic, pneumatic, hydraulic and mechanical devices and equipment to specifications.

In Attendance: Earl F. Hash, Pres.; S. H. Isaacs, V. P. Sales; Marvin C. Care, Sales Rep. East Central; T. Hutson, Shop Supt.; Kenneth Glascow, Ch. Draftsman.

Industrial Instruments, Inc.
Jersey City 5, New Jersey 525

Exhibiting: New Products—Type RI self-balancing ac. bridge indicator and controller, provision for 4 on-off points of control or 0-15 lbs. air, specifically designed for electrolytic conductivity measurements. **Regular Products**—Solu-Bridge; Solu-Bridge controller; Line of electrolytic conductivity apparatus.

In Attendance: Philip M. Gotthold, Pres.; Dr. Robert Rosenthal, Ch. Chemist.

Industrial Laboratories Publishing Co.
Chicago 6, Illinois 819

Exhibiting: "Industrial Laboratories" Magazine.

In Attendance: Frank D. Thompson, Publisher & Pres.; William H. Relyea, Jr., V. P.; Fred Grant, V. P.; Gilbert Thayer, Paul Weidenschilling, District Managers.

Industrial Nucleonics Corp.
Columbus 12, Ohio 624, 626

Exhibiting: AccuRay beta gauge with a pictorial presentation of the uses of the AccuRay in indsutry.

In Attendance: K. E. Hopkins, Dir. Marketing; L. L. Eberhart, S. M.; James Orr, Sales Engr.; James Rhodes, Application Engr.; G. M. Butler, Sales Pro. Mgr.

Industrial Pyrometer and Supply Co.
Alton, Illinois 411, 413

Exhibiting: New Products—New type insulation for thermocouple lead wires furnished in both iron-constantan and chromel-alumel, suitable where high temperatures and moisture conditions are prevalent. **Regular Products**—Insulated thermocouple lead wires; insulated thermocouple wires; bare thermocouple wire; protection tubes; insulators; thermocouple heads.

In Attendance: Avery L. Hack, Pres.; Franklin L. Hack, Gen. Mgr.; Jacob G. Hack, Ch. Engr.; A. J. McBride, Special Rep.

Industrol Corporation
Roselle Park, New Jersey 610

Exhibiting: New Products—Midget dehumidifier for use with gas analysis instruments. **Regular Products**—Dynamic dehumidifiers for instrument air; Centrisorb air filters.

In Attendance: George R. Feeley, Pres.; James V. Mannion, V. P.; Robert C. Axt, Sales Engr.; Robert Hyer, Sales.

Institute of Radio Engineers, Inc.
New York 36, New York .....Stage

Exhibiting: New Products—Information on Professional Groups of the I. R. E. **Regular Products**—*Proceedings of the I. R. E.*; I. R. E. Directory (Annual); Professional group publications, membership applications.

In Attendance: William C. Copp; Mrs. William C. Copp.

Instrument Development Laboratories, Inc.
Needham Heights 94, Mass. 828

Exhibiting: New Products—Colorede, a highly stable quantitative photoelectric instrument for process control through light measurement, moisture-tight and explosion-proof construction. **Regular Products**—Color-eye.

In Attendance: George P. Bentley, Pres.; Alexander R. MacDonald, Sales Rep.

Instrument Laboratory Service
Columbia Station, Ohio 834

Exhibiting: New Products—Electronic tachometer, range 0-10,000 r.p.m., accuracy plus or minus 1 r.p.m., for conventional and explosion-proof installations. **Regular Products**—Electric tachometer and generator. Aircraft instrument overhaul, mechanical and electronic development.

In Attendance: Robert B. Laule, Owner; George R. Lippert, Engr.; Roy Miles, Jr., Technician.

Instrument Society of America
Pittsburgh 33, Pa. .....Stage

Exhibiting: Publications of I.S.A.; Recommended practices; *I.S.A. Journal*; Preprints; Proceedings; Technical papers; Services to I.S.A. members; Society information and literature; I.S.A. pins.

In Attendance: I.S.A. National Officers, I.S.A. National Office Staff, members of Cleveland Section I.S.A.

Instruments Publishing Co.
Pittsburgh 12, Pa. 307, 309

Exhibiting: *Instruments*—the Magazine of Measurement and Control; *The Instruments Index*—the bi-annual buying directory for instrument users and buyers; *Instrument Manufacturing*—the trade journal of the Instrument Industry; *The Handbook of Measurement & Control; Instrument Manufacturing Guide*—the bi-annual directory of the parts manufacturers for the Instrument Industry. Books: "Instrumentation for the Process Industries"; Instrumentation for the Iron & Steel Industry"; "Maintenance and Servicing of Electrical Instruments" by James Spencer; "Operation and Care of Circular-scale Instruments" by James Spencer; "A Romance in Research—The Life of C. F. Burgess" by A. McQueen; "Applications of Industrial pH Controls" by Allen Chaplin; "Mechanical Measurements by Electrical Methods" by Howard Roberts; "Heat Inertia in Problems of Automatic Control of Temperature" by Victor Broida; "Scientific and Industrial Glass Blowing and Laboratory Techniques" by W. E. Barr and Victor Anhorn; "Elementary Engineering Electronics" by Andrew Kramer; "The Engine Indicator—Its Design, Theory and Special Applications" by K. J. DeJuhasz; "Pittsburgh International Conference on Surface Reactions"; "Guide to Foreign Sources of Metallurgical Literature" by John Milek; "Ophthalmic Glossary" by Dr. M. R. Goldman.

In Attendance: Richard Rimbach; M. F. Behar; M. H. Aronson; James Emge; Richard Rimbach, Jr.; C. F. Goldcamp; M. D. Pugh; Harold Haskett; James Condon; Steve Wright.

J-B-T Instruments, Inc.
New Haven 8, Conn. 311

Exhibiting: New Products—1½ and 3½ in. sealed vibrating-reed frequency meters, individually tested for 55,000-ft. altitude, in various reed combinations for 60 and for 400 cycles; 400-cycle a.c. elapsed time meters (sealed), also 60-cycle sealed; Model 41-FX frequency meter as 400-cycle working standard, broad range 300-500 cycles with 21 reeds, vernier reading 380-420 with 13 reeds. **Regular Products**—Vibrating-reed frequency meter; Instrument-quality rotary selector switches, 14 and 20 position, molded and laminated types; Lever switches, 3 and 4 positions; Pyrometers and resistance thermometers; Elapsed time meters, a.c.; 2 in. inexpensive electrical panel instruments by subsidiary (Shurite meters). Operates Eastern Service Division on Triplett instruments and electronic test equipment.

In Attendance: Roland M. Bixler, Pres.; Louis J. Umile, Ch. Engr.; Carl Iaccarino, Development Engr.; Alick Richardson, Project Engr.

Jerguson Gage and Valve Company
Somerville 45, Mass. 121

Exhibiting: New Products—Complete line of specialized valves for instrument piping jacketed, throttling, bolted bonnet, union bonnet, or with renewable seats, etc., and new type electric repeater with 0.5 percent accuracy of scale reading for remote indication of level; Mercury bulb illuminator. **Regular Products**—Liquid level gages and gage valves. Engineering service on level indication problems.

In Attendance: James A. Ford, V. P.; E. E. van Ham, V. P.; H. R. Bowers, Local Rep.

Karn Chemical Equipment Co.
Pittsburgh 2, Penna. 815

Exhibiting: Thermowells.

In Attendance: James B. Karn, Owner.

W. A. Kates Company
Deerfield, Illinois 602

Exhibiting: New Products—Kates direct acting flow rate regulator for control of liquid flow under varying pressure.

In Attendance: Willard A. Kates, Pres.; Tom Coghill, Chicago Rep.; William J. Hegerty, Eastern Rep.

Kato Meters, Inc.
Dallas, Texas 632

Exhibiting: Surface finish examination devices.

In Attendance: P. T. Miner; H. C. Collins.

C. M. Kemp Manufacturing Company
Baltimore 2, Maryland 812

Exhibiting: New Products—Full-automatic adsorptive dryer, all operations controlled by program timer eliminating operator error. **Regular Products**—Standard Oriad radiation cooled and convection cooled dryers for air and gases; Liquid dryers; Dehumidifiers. Design and engineering service.

In Attendance: Edward J. Funk, Jr., V. P. Engg.; Robert R. Goll, Sales Engr.; Robert L. Hill, Mgr. Field Engg.; W. C. McDonough, R. J. McDonough, R. Van Nostrand, Don Davis, Cleveland Sales Reps.; W. A. Scheffler, Akron Sales Rep.; W. W. Drissen, T. P. Stevens, Detroit Sales Reps.; Earl Genn, F. D. Logan, Chicago Sales Reps.

Kieley and Mueller, Inc.
North Bergen, New Jersey 537, 539

Exhibiting: New Products—Sweep Flow angle control valves. **Regular Products**—Control valves and regulators for the process industries. Design engineers of fluid control valves.

In Attendance: Joseph O'Connor, Pres.; Robert J. Donnelly, V. P. Sales; Ward K. Stallings, V. P. Engg.; Norman Lieblich, George W. Hansen, A. A. Bailey, Sales Engrs.; District Representatives from New York, Boston, Phila-

delphia, Charlotte, New Orleans, Cleveland, Pittsburgh, Detroit, Tulsa, Los Angeles, San Francisco, Portland and Seattle.

King Instrument Company
Cleveland 13, Ohio 724, 726, 728

Exhibiting: Products of King Engineering Co.: liquid level gages, manometers; Products of Lumenite Electronic Co.: liquid level controls, timers; Products of United Electric Controls Co.: thermostats, pressure switches; Products of Brooks Rotameter Co.: flowmeters and controls; Products of Norcross Corp.: indicating, recording, controlling viscometers.

In Attendance: G. D. Carnegie, Mgr.; J. B. Larimore, Branch Mgr.; J. Flood, Sales; M. W. Courtnght, Service Mgr.; Betty Pray, Sec.; Anne Carnegie, Hostess.

Lapp Insulator Company
LeRoy, New York 325, 327

Exhibiting: New Products—Auto-pneumatic Pulsafeeder, a controlled volume pump with automatic flow rate change, an air cylinder mechanically connected to the stroke adjustment changes stroke length in response to and in direct relation to a 3 to 15 psig instrument air signal. **Regular Products**—Pulsafeeder controlled volume pumps.

In Attendance: Lawrence F. Wilson, Mgr. Pulsafeeder Div.; Victor Leipold, Service Engr.; D. P. Turner, Cleveland Sales; Harold Baker, Akron Sales; John Homer, Pittsburgh Sales; O. R. Lawrence, Buffalo Sales; Harry Reed, Detroit Sales.

G. H. Leland, Inc.
Dayton 2, Ohio 931

Exhibiting: New Products—Stepping relays in explosion-proof enclosures. **Regular Products**—Rotary solenoids; Circuit selectors.

In Attendance: Gerald Leland, V. P. & Gen. Mgr.; Harold Leland, V. P. & Ch. Engr.; Charles T. Davis, Factory Mgr.; David F. Warner, Engr.; Russell Moubray, Sales Engr.; Hans G. Belitz, Special Assignments Engr.

Leslie Company
Lyndhurst, New Jersey 321, 323

Exhibiting: New Products—Double-seated diaphragm control valves designed for simplified maintenance and including "Flow-line" contoured body, renewable interchangeable seat rings, renewable self-aligning guides, Stellited seating surfaces, choice of trim materials, through-bolt construction, flanged stuffing box, etc. **Regular Products**—Reducing valves; Pressure and temperature controllers; Pump governors, Steam whistles; Air horns and strainers.

In Attendance: John S. Leslie, Pres., Russell W. Boettiger, Sales Mgr.; Warren M. Wilson, Arthur J. Dromm, J. V. Tripoli, J. Coffey, H. G. Jones, Sales Engrs.

Librascope, Inc.
Glendale 1, Calif. 214

Exhibiting: New Products—Computing spectrophotometer of null type employing a double monochromator (3800-700 Angstroms) and incorporating a computer for evaluation of tristimulus valves; X-Y recorder two-axis stationary chart recorder adaptable for point plotting from keyboard, punched cards and perforated tape or continuous curve plotting; Square-root planimeter motor driven with counter readout designed for use with miniature strip chart recorders. **Regular Products**—Analog computing components. Design of analog and digital computers and allied instrumentation.

In Attendance: E. W. Silvertooth, Commercial Sales Engr.

Lord Manufacturing Company
Erie 6, Pa. 706

Exhibiting: New Products—"Temproof" all-weather equipment mountings for aircraft and industrial use; Base mounted racks for radio and electronic equipment; Silicone and silastic vibration control mounts for extreme high and low temperature exposures; Z type bonded-rubber mounts for lightweight instruments and associated equipment affording minimum installation space. **Regular Products**—Bonded-rubber plate-form, tube-form and special vibration isolation mountings; Idler wheels; Multiplane mounts; Bonded-rubber diaphragms; Tube socket vibration isolators; Bonded-rubber flexible drive couplings; Signal Corps type shock mounts for mobile electronic equipment; Radiofocal rack mounts and special bonded-rubber mechanical parts.

In Attendance: Geo. E. Tubb, Gen. Sales Mgr.; C. L. Freel, Mgr. Field Engg. Dept.; R. C. Henshaw, Mgr. Product & Sales Engg. Dept.; G. H. Waite, W. M. Waldbauer, Product & Sales Engrs.

Magnetrol, Inc.
Chicago 23, Illinois 223

Exhibiting: New Products—Model TF62F and Model TF63 side mounting float switches; Model 401 and Model W-254 external float cage units; Operating model of displacement type Magnetrol. **Regular Products**—Liquid level controls, top mounting, side mounting and external float cage styles. Consulting service on liquid level control applications.

In Attendance: Lester E. Stybr, Sales Mgr.; B. L. Binford, Chief Engr.; J. R. Vonesh, R. De Meyer, Sales Engrs.; Representatives of Illes Power Control Company of Cleveland.

Marine and Industrial Products Co.
Philadelphia 4, Pa. 333, 335

Exhibiting: New Products—Mipco safety and relief valves, ASME and U. S. Coast Guard approval; Steam jacketed safety relief valves for outdoor installation under freezing conditions. **Regular Products**—Pop safety valves, relief valves, pump by-pass valves, vacuum breakers.

In Attendance: Joseph Schubert, Pres.; Frank Schubert, Treas.; Fred H. Sklenar, Ch. Engr.; V. McCaffery, S. M.; J. Petrosius, Engr.

Mason-Neilan Regulator Company
Boston 24, Mass. 435, 437, 439

Exhibiting: Industrial instruments; Control valves.

In Attendance: F. K. Morrison, V. P. Sales; E. A. Bianchi, Dir. of Engg.; C. W. Freeman, Mgr. Application Engg. Dept.; C. W. Gram, N. Y. District Mgr.; T. M. Nee, Syracuse District Mgr.; W. F. Priest, New England District Mgr.; J. W. Robins, Mgr. Instrument Development; G. R. Thomason, Chicago District Mgr.; P. Wing, Jr., Mgr. Application Engg. Development; C. W. Wood, Philadelphia District Mgr.; R. Glomeau, Paris, France Associate.

M-B Manufacturing Company
New Haven 11, Conn. 917

Exhibiting: New Products—Automatically-controlled fatigue tester operating at resonance of test specimen, a self-excited system with means for controlling stress level on specimens, automatic shut-off when specimen fractures. **Regular Products**—Vibration exciters and calibrators; Vibration meter; Vibration pickups; "Isomode" vibration isolators; "Isomode" pad. Engineering service: design, development and testing to government specifications.

In Attendance: E. G. Oravec, W. W. Jarowey, E. J. Bligard, A. C. Deichmiller, E. E. Peavoy, Sales Engrs.; Karl Unholtz, Chief Engr.; F. G. Mahannah, J. O. Olsen, Sales Reps.

Meletron Corporation
Los Angeles 38, Calif. 722, 821

Exhibiting: New Products—Fluid controls and pressure actuated-switches. **Regular Products**—Barksdale valves; Crescent valves; Meletron pressure-actuated switches.

In Attendance: L. S. Barksdale, Carl Grier, M. C. Nelson, Jim Brown.

Meriam Instrument Company
Cleveland 2, Ohio 518, 520

Exhibiting: Manometers; Inclinometers; Absolute pressure gages; Liquid level gages; Contactor manometers; Micromanometers; Draft gages; Flowmeter; Accessory items.

In Attendance: J. B. Meriam, Jr. Pres.; A. A. Hejduk, V. P. Engg. & Sales Engr.; Mark Meriam, Sales Engr.; Leroy E. Rogers, Sales Mgr., Inst. Div.; O. W. Heyman, Technical Research Engr.; H. R. Bowers, Cleveland Rep.

Metrotype Corporation
Chicago 20, Illinois 533

Exhibiting: New Products—High-speed impulse totalizer and telemetering. **Regular Products**—Metrotype printing type of recording instrument; Metrofault line of fault-detecting instruments.

In Attendance: George E. Foster, Ch. Engr.

Micro Switch
Freeport, Illinois 921

Exhibiting: Standard line of Micro precision products, including basic switches, metal enclosed switches, limit switches, subminiature and hermetically-sealed switches.

In Attendance: A. W. Wacaser, Central Div. Mgr.; R. A. Heinrich, Field Engr.

Micrometrical Manufacturing Company
Ann Arbor, Michigan 702, 704, 801, 803

Exhibiting: Profilometer.

In Attendance: Frank W. Kabat, Head Field Rep.; Arnold Loyd, George Haber, Bernard Poland, Field Reps.; M. L. van Benschoten, Adv. Mgr.; Claybourne Mitchell, Physicist; Norman Gortz, Research Dept.; Ernest J. Abbott, Gen. Mgr.

Midwestern Geophysical Laboratory
Tulsa, Oklahoma 901

Exhibiting: New Products—Model 560 oscillograph, high gravity recording instrument; Multiple dynamic meter, multi-channel recording instrument for aircraft panel. **Regular Products**—Oscillographs, galvanometers, servovalves, servoamplifiers, torque motors.

In Attendance: M. E. Morrow, Pres.; G. R. Morrow, R. D. Atchley, D. G. O'Brien, Vice-Presidents.

Milton Roy Company
Philadelphia 18, Pa. 401, 403

Exhibiting: Milton Roy motor driven simplex controlled volume pumps; aiRoymetric hydrostatic pressure generator; mimiPump with pneumatic stroke length/capacity control; mimiPump Constrametric; Titronic (automatic pH control) and motorized micro (stroke length/capacity control) pump.

In Attendance: R. T. Sheen, Pres.; D. H. Jones, S. M.

Miniature Precision Bearings, Inc.
Keene, New Hampshire 727, 729

Exhibiting: New Products—New bearings. **Regular Products**—120 different types and sizes of miniature ball bearings. Engineering and application services.

In Attendance: H. D. Gilbert, Pres.; W. M. Scranton, V. P. Production; W. L. Timmerman, Eastern Dist. Mgr.; K. G. Broman, New England Rep.

Mine Safety Appliances Company
Pittsburgh 8, Pa. 301, 303

Exhibiting: Combustible gas indicator and alarm; CO tester and indicator; Explosimeter; Midget impinger; Electrostatic dust sampler; Lira infra-red gas analyzer; Hydrogen sulphide detector; Samplair; Geiger counter; etc. Consultation and recommendations on process control instruments.

In Attendance: N. W. Hartz, J. P. Sherwin, J. E. Gray, L. E. Maley, V. J. Elliott, John Gilmore, C. H. Mehaffey, J. W. McCrackin.

Minneapolis-Honeywell Regulator Company, Valve Division
Philadelphia, Pa. 606, 608

Exhibiting: New Products—Pressure pilot, for pressures from 0 to 1500 psi, convenient set point adjustment, overpressure safeguard and ease of reversibility. **Regular Products**—Diaphragm-motor valves; Venturi throat valves; Low flow valves; Air-O-Motors; Narrow-band proportioning valve.

In Attendance: K. R. Knoblauch, Valve Div. Sales Mgr.; A. J. McCullough, Regional Ind. Mgr.; A. O. Pearson, Ass't. to Valve Div. Sales Mgr.; W. T. Rockhill, Exhibit Mgr.; A. F. Day, D. P. Moreland, G. S. Mountford, R. C. Schumacher, R. F. Weisehan, J. F. Kramer, H. D. Fox, T. L. McDonald, D. E. Yerks, H. N. Andrew, Sales Engrs.; J. F. Wright, Service Mgr.; E. Wolff, Chief Engr.; W. Thomas, J. Wiedman, H. Michel, R. Rockwell, Engrs.; R. M. Woodside, Ind. Mgr.; R. R. Scott, Regional Valve Sales Mgr.

Mittelmann Electronics Corp.
Chicago 6, Illinois 317, 319

Exhibiting: Electronic instruments.

In Attendance: Dr. Eugene Mittelmann; Wallace H. Coulter; R. A. Whiteman.

Samuel Moore and Company
Mantua, Ohio 331

Exhibiting: New Products—Sheating with plastic multiple instrument air lines tubes. **Regular Products**—Dekoron coated instrument air line tubing; Dekron coated electrical conduit. Coating of tubing with polyethylene and vinyl for corrosion proofing.

In Attendance: Frank Olton, Exec. V. P.; Robert Brumback, Ch. Engr.; R. B. Burnham, Sales Mgr.; James Rogers, Ass't. Sales Mgr.; Fred Williams, Salesman; John Steven, Chas. Holz, Sales Reps.

Nash Engineering Company
South Norwalk, Conn. 320, 419

Exhibiting: New Products—Non-lubricated "Clean Air" compresser, delivering absolutely clean instrument air, without dust, heat or oil. **Regular Products**—Air compressors; Vacuum pumps; Return line heating pumps; Laboratory pumps of Pyrex brand glass.

In Attendance: I. C. Jennings, Pres.; E. A. Mead, Gen. Sales Mgr.; H. E. Adams, Chief

Engr.; F. W. Green, Mgr. Ind Sales; J. B. Wright, Mgr. Building Sales; G. B. Wright, Publicity Mgr.; E. A. Barton, J. B. McGregor, C. H. Love, G. W. Clucas, K. Keitch, E. P. Bradley, C. Saints, Jr., F. N. Schaad, Sales Engrs.

National Bureau of Standards
Washington 25, D. C. 923, 925

Exhibiting: Instrumentation research at NBS, with emphasis on recent developments such as a new velocity pickup, noise-free instrument cable, carbon dioxide hypsometer and a radiofrequency operated photomultiplier; Demonstrations of the measurement of the characteristics of motion, and of pressure-measuring instruments and calibrations from very low pressures to very high pressures.

In Attendance: Dr. T. A. Perls; E. G. Lloyd; A. S. Iberall; C. L. Bragaw.

National Spectrographic Sales Corp.
Cleveland 3, Ohio 703

Exhibiting: New Products—"Spec-Reader" densitometer, console model, easy-to-read screen with complete observation of line during reading, foot switch. **Regular Products**—"Spec-Power" excitation unit; "Arc-Spark" stand designed for heavy duty; Laboratory sample preparation accessories. Commercial laboratory for spectrographic analysis, polarigraphy and colorimetry for quality control and research.

In Attendance: H. M. Bedell, Exec. Officer; D. R. Moore, Pres.; R. H. Bell, V. P.; N. A. Grondin, E. Spitzer, E. Perout, R. E. Schall.

New Hermes Engraving Machine Corp.
New York 3, New York 506

Exhibiting: Portable and bench type pantograph engraving machines, for both metal and plastic, to engrave panel, dials, name plates, etc.

In Attendance: Norbert Schimmel, Pres.; G. G. Gruettner, Engr.; Morris Kaufman, Henry Susskind, Sales Reps.

North American Philips Company, Inc.
Mt. Vernon, New York 529, 531

Exhibiting : New Products—Quartz analysis unit featuring proportional counting tube enabling high operating efficiency, simplified mount for optical parts, console model with new dial controls. **Regular Products**—Water-cooled x-ray diffraction apparatus with wide-range high- and low-angle goniometer and electronic circuit panel; Circuit panel; Scaling circuit and rate meter; Fluorescence analysis unit; Electron microscope with direct view screen and resolution.

In Attendance: C. J. Woods; J. S. Buhler; E. F. Champaygne; F. A. Behr; T. P. Turnbull; R. Seibert; J. C. Mead.

Ohmart Corporation
Cincinnati 38, Ohio 616

Exhibiting: Introducing a new method of measuring many process variables using radioactive materials and Ohmart cells as the measuring medium, operating equipment will be shown; Gammometers; Radiation monitors.

In Attendance: Philip E. Ohmart, Pres.; Yeatman Anderson, S. M.; H. L. Cook, Ch. Engr.

Palmer Thermometers, Inc.
Cincinnati 12, Ohio 514, 516

Exhibiting: New Products—4½ in. dial thermometers, electrical contact type. **Regular Products**—Industrial, laboratory, dial and recording thermometers.

In Attendance: Bartlett Palmer, Pres.; C. P. Mitchell, V. P. Engg.; Douglas H. Hitt, Sales Mgr.; C. C. Bernitt, Ch. Drafting Engr.; Frank W. Probst, Mac Mofford, Sales & Service Engrs.; H. R. Bowers, Cleveland Mfg. Rep.

Panalarm Products, Inc.
Chicago 40, Illinois ..434, 436, 438, 440

Exhibiting: New Products—Model 500 redesigned multiple purpose Panalarm. **Regular Products**—Signal systems, level indicators (illuminated) manual loaders. Engineering, design and fabrication of alarm systems.

In Attendance: A. F. Sperry, Pres.; M. B. Lorig, V. P.; R. A. Anderson, V. P. Panascan; N. Blair, M. Shriver, W. Dumser, R. Eurick, O. Akerland, H. Waren, G. Mitchell, A. Hudson, A. Bosso, W. Wright, Sales Mgrs.

Panascan, Inc.
Chicago 40, Illinois ..434, 436, 438, 440

Exhibiting: New Products—High-speed scanning systems for thousands of variables. **Regular Products**—Monitoring and scanning systems, electric testing systems. Engineering, design and fabrications of monitoring systems.

In Attendance: A. F. Sperry, Pres.; M. B. Lorig, V. P.; R. A. Anderson, V. P. Panascan; N .Blair, M. Shriver, W. Dumser, R. Eurick, O. Akerland, H. Warren, G. Mitchell, A. Hudson, A. Bosso, W. Wright, Sales Mgrs.

Panellit, Inc.
Chicago 40, Illinois ..434, 436, 438, 440

Exhibiting: New Products—Educational display: controlling difficult processes. **Regular Products**—Graphic panels, standard panels, cubicles. Engineering, design and fabrication of complete control systems.

In Attendance: A. F. Sperry, Pres.; M. B. Lorig, V. P.; R. A. Anderson, V. P. Panascan; N. Blair, M. Shriver, W. Dumser, R. Eurick, O. Akerland, H. Warren, G. Mitchell, A. Hudson, A. Bosso, W. Wright, Satels Mgrs.

Parker Appliance Company
Cleveland 12, Ohio 225, 227

Exhibiting: Tube fittings and tools; O-rings.

In Attendance: S. E. Voran, Adv. Mgr.; P. Kozak, Jr., Ass't. Adv. Mgr.; D. W. Holmers, V. P. Sales; C. E. Klamm, Tech. Ass't. to Pres.; H. C. Jacob, Gordon Miscall, James F. Walters, Sales Mgrs.

Penberthy Injector Company
Division Buffalo-Eclipse Corporation
Detroit 2, Michigan 536

Exhibiting: New Products—Liquid level gages with patented floating shank valves; Saran plastic ejectors; 10,000-psi liquid level gages. **Regular Products**—Liquid level gages; Ejectors; Exhausters; Sump pumps; Cellar drainers; Injectors.

In Attendance: F. E. Ruebelmann, V. P.; H. Strohmaier, Sales Supvr.; C. Denis, Chief Engr.; A. Lindeman, C. Hamilton, Engrs.; C. A. Jennings, R. Sanford, Ray Williams, J. Keegan, Sales.

Perkin-Elmer Corporation
Norwalk, Conn. 313, 315

Exhibiting: New Products—Model 112 infrared spectrometer featuring a unique double-pass optical system resulting in freedom from scattered radiation and greatly improved resolution; Model 13 infrared spectrophotometer, a new double-beam instrument of extreme versatility for all infrared applications. **Regular Products**—Model 21 double-beam infrared spectrophotometer; Model 52C flame photometer; Model 38 Tiselius electrophoresis apparatus. Optical designers and consultants, custom-made optical and electro-optical instruments.

In Attendance: Paul A. Wilks, Ass't. Dir. Sales & Research; John O'Connell, Service Mgr.; Seymour G. Linsley, John Rhodes, Sales Engrs.

Permutit Company
Panarex Division
New York 36, New York 512

Exhibiting: New Products—Ranarex pneumatic transmission controlling and remote recording. **Regular Products**—Ranarex combustion indicators and recorders; Specific gravity indicators and recorders; Furnace atmosphere analyzer; Exhaust gas analyzer; Stationary and portable equipment.

In Attendance: F. D. Harger, N. Y. Mgr.; Franklin Leslie, N. Y. Rep.; H. G. Brown, Cleveland Rep.

Photoswitch, Inc.
Cambridge 42, Mass. 426

Exhibiting: General-purpose and delayed-action photoelectric controls; Counters (photoelectric); Electronic timers; Liquid level controls; Electronic pilot relays; Registration controls (photoelectric).

In Attendance: John A. Long, Executive V. P.; T. A. McCollum, Ass't. Sales Mgr.; John B. Sullivan, Eastern Sales Mgr.

Potter Aeronautical Company
Newark 2, New Jersey 328

Exhibiting: New Products—Potter-Brown electronic flowmeter, a wide-range linear flow-indicating or recording instrument available with direct-reading specific gravity compensation. **Regular Products**—Electric flow sensing elements for measuremenets from 0.07 to 3000 gpm; Model 3 integrator; Model 6 integrator and totalizer. Advisory service on flow problems.

In Attendance: David M. Potter, Irving Hirsch, Robert Schooley, Richard Franks, Harry Whittle, Carl Faust.

Potter and Brumfield
Princeton, Indiana 813

Exhibiting: Relays.

In Attendance: R. M. Brumfield, Pres.; R. T. Brengle, V. P. Gen. Sales Mgr.; E. P. Scott, Del Steffen, John Crosby, Representatives.

Potter Instrument Company
Great Neck, New York 414

Exhibiting: New Products—Model 470 8-Mc. counter-chronograph for time interval measurement accurate to 0.125 microsecond; Frequency-time counters for precision frequency measurement, time-interval measurement and tachometry in easy-to-read digital form; "Teledeltos" digital recorders, new accessory equipment for recording electronic counter totals at rates up to 150 per second. **Regular Products**—High-speed electronic counters and scalers; Precision chronograph and timing instruments; Frequency measurement counters; Electronic digital computers and memory devices; High-speed printer units and data handling equipment.

In Attendance: John T. Potter, Pres.; John J. Wild, V. P.; John B. Flynn, E. B. Hitchcock, Sales Engrs.

Process Controls
Cambridge 38, Mass. 709, 711

Exhibiting: Plant Stream Analyzer, a continuous automatic controller which has high sensitivity with high discrimination wherever process stream concentration of an infrared absorbing material is a criterion.

In Attendance: S. H. Walters, J. M. Devine, H. Short, L. H. Lyon, Glen Smith, W. A. Patterson.

Production Instrument Company
Chicago 6, Illinois 814

Exhibiting: New Products—"Mercury" 4-digit reset counter; Telephone message counter; "Midget" mechanical reset counter; Model EJ 6-digit reset counter; "Selectometer" for tape recorder. **Regular Products**—"Wizard" electric counters; "Mercury" electric counters; "Silver King" stroke and revolution counters; "Clipper" coil winding counters; "Monitor" automatic batch counters; Actuating switches.

In Attendance: C. A. Robinson, Territory Rep.; Joseph F. Visin, Sales Mgr.; R. J. Visin, Jerry L. Jedd, Engr.

Proportioneers, Inc.
Providence 1, Rhode Island 431, 433

Exhibiting: New Products—Micro-feeders, low-capacity high-pressurization laboratory type metering unit for up to 10 cc per hour continuous feed at 2000 psi.; X-52 adjust-O-Feeder, economical compact simplex metering pump for 5 gph or 10 gph at pressures up to 650 psi.; Two-component blender, for accurate control of two fluids in blending operations at any ratios from 95-5 to 5-95, usability for any fluids which can be metered with mechanical meters. **Regular Products**—Adjust-O-Feeder controlled volume metering pump; Treet-O-Unit contolled-volume metering pump; Loss-In-Weight gravimetric feeders; Chem-O-Feeder diaphragm metering pump; Heavy-duty midget Chlor-O-Feeder. Engineering service on proportioning and blending problems.

In Attendance: R. P. Lowe, Pres.; R. H. Glanville, V. P.; E. F. Pickering, Ind. Sales Mgr.; P. V. Crowther, Appl. Engr.; H. R. Bowers, G. A. Horlacher, Cleveland Reps.

Pyrometer Instrument Company
Bergenfield, New Jersey 523

Exhibiting: New Products—Pyro surface pyrometers with selection of ten interchangeable thermocouples and quick-change connector for all surface and subsurface temperature measurements; Pyro micro-optical pyrometer, laboratory type for remote temperature readings or for extremely small objects at varying focal distance. **Regular Products**—Pyro pyrometers—radiation, indicating, immersion, and optical.

In Attendance: A. Bollerman, Pres.; Paul V. Bollerman, V. P.; C. G. Bollerman, Sec.

Robinson Aviation, Inc.
Teterboro, New Jersey 734

Exhibiting: New Products—Engineered anti-vibration mounting systems for special equipment, each system designed to meet custimers' exact dimensional and specification requirements. **Regular Products**—Vibration isolators; Shock mounts; Mounting bases; Mounting systems. Vibration control engineers for consultation and application.

In Attendance: C. S. Robinson, Pres.; H. Erich Nietsch, Asst. to Press.; Robert A. Sprung, Sales & Adv. Mgr.

Rockwell Manufacturing Company
Pittsburgh 8, Pa. 338, 340

Exhibiting: New Products—Differential controller for change-over valve designed to provide positive means of automatically turning an additional measuring unit into a gas line when needed and effecting complete shut-off when not required. **Regular Products**—Remote

registration unit; "201" orifice meter; Chart drives, hubs and turrets; Integrator.

In Attendance: C. C. Moore, Pittsburgh Dist. Sales Mgr.; J. L. Cottrell, Mgr. Integrators & Orifice Meters; P. C. Kreuch, Central Regional Sales Mgr.; E. A. Mowrey, P. H. Luckett, Sales Engrs.

Rowe Industries
Toledo 9, Ohio 705

Exhibiting: New Products—Air modulator, high efficiency unit to amplify speech to very high intensities, industrial units for noisy locations are attached to existing intercom lines and air service lines. **Regular Products**—Vibration pickups; Pickups; Loud speakers; High-voltage corona-free transformers and metering devices. Complete development from initial drawings to prototypes and production of electro mechanical products. Custom instrumentation, test equipment, amplifiers, aircraft antennas, cables and special molded rubber cable ends.

In Attendance: H. N. Rowe, Owner, L. R. Klopfenstein, Engg.; H. H. Donnelly, H. M. Klopping, Sales.

Roy Horton—Research Controls
Tulsa, Oklahoma 707

Exhibiting: New Products—Miniature control instruments. **Regular Products**—Valves, diaphragm-motor operated 2-15 psi.; Tubing pinch; Relays; Balanced valves; Differential relays and specials—all of corrosion resistant materials; Throttling plugs, ½-in. maximum pipe size; Standard accessories. Custom valves and instruments, pilot-plant and research-laboratory control specialties.

In Attendance: Roy Horton, Manager; P. M. Sanders, Consultant; W. A. Diament, W. J. Claffie, Joseph H. Bertram, A. Costa, C. W. Snyder, Sales.

R-S Products Corp.
Philadelphia 44, Pa. ..330, 332, 334, 336

Exhibiting: Butterfly valves; Strainers; Shock absorbers; Leveltronic control system.

In Attendance: R. C. Ayers, Sales Mgr.; D. C. Culver, H. Hollingsworth, W. O. Ressler, W. G. Butler, R. S. Williams, Sales Mgr.

Sanborn Company
Cambridge 39, Mass. 236

Exhibiting: Several single- and multi-channel models of the Sanborn direct-writing recorders, permanent records, no ink and true rectangular co-ordinates; Interchangeable ac. and dc. preamplifiers; Interchangeable drive amplifiers of dc., strain-gage and other types; Auxiliary components such as Triplexer and threshold monitor.

In Attendance: A. E. Lonnberg, Sales Mgr.; Dr. Arthur Miller, Sr. Research Engr.

Sarco Company, Inc.
New York, New York 820

Exhibiting: Self-operated temperature regulators; Electric temperature controllers; Steam traps.

In Attendance: H. F. Colling, A. Milnes, Directors; M. J. Marion, Adv. Mgr.

Scientific American, Inc.
New York 36, New York 719

Exhibiting: General scientific and technical journal reporting each month the leading developments in all fields of science and research.

In Attendance: Gerard Piel, Publisher; Charles E. Kane, Adv. Dir.; David C. Hessey, Western Mgr.; Martin M. Davidson, Ass't. Adv. Dir.

Scientific Apparatus Makers Association
Chicago 6, Illinois .....Stage

Exhibiting: An institutional booth to inform makers and users of instruments, about the Scientific Apparatus Makers Association.

Servo Corporation of America
New Hyde Park, New York 620

Exhibiting: New Products—Model 1121 Reluctance amplifier for use with a.c. servomotors, operates directly from a.c. power line, unique circuit eliminates power transformer. **Regular Products**—Servoscope; Servoboard; Servo amplifier; Servotherm thermistor bolometers; Servotherm bolometer preamplifier; Servotherm thermistor power unit. Custom design, development and production of rf. systems and instrumentation, infrared radiation instrumentation, servo system, servo analysis and synthesis equipment.

In Attendance: Henry Blackstone, Pres.; J. H. Lasley, Contract Supvr.; F. G. Willey, Engr.-in-charge, Electronics Dept.; Wm. Derganc, Staff Engr.; S. N. Howell, Administrative Ass't.

Servomechanisms, Inc.
Westbury, L. I., New York 915

Exhibiting: New Products—"RD101" 6-in. strip-chart recorder, provides an error record of electrical or mechanical components; Pot checker, accessory device for strip recorder for checking potentiometers and rotary transducers. **Regular Products**—Angle of attack computer; Servo components including amplifiers, power supplies, modulators, transducers, motors, adapters; Range computers; Mechanical development apparatus. Design, development and production of precision electronic and electromechanical products.

In Attendance: C. H. Hartley, Customer Liaison Director, H. Brede, J. R. Crawford, Sales Engrs.; L. C. Briggs, Adv. & Public Relations.

Shand and Jurs Company
Berkeley, Calif. 827

Exhibiting: New Products—Remote-reading automatic tank gage equipment. **Regular Products**—Standard automatic tank gage for local and remote reading.

In Attendance: A. E. Jurs—Partner, Chief Engr.; J. S. Hawley, Elect. Engr.; R. W. Blake, Mgr. Chicago Office; R. F. Ley, Mgr. New York Office; J. T. Drumm, Asst' Mgr. New York Office.

S. Morgan Smith Company
York, Pa. 330, 332, 334, 336

Exhibiting: Butterfly valves; Roto valves, non-lubricated cone type; Package accumulator system; Poppet type safety valve; Howell Bunger valves.

In Attendance: Carl Wilcox, Mgr. Valve Div.; Harry Shives, Curtis W. Lau, Maxfield Pease, Robert E. Coates, J. H. Whisler, Sales Engrs.

Sorensen and Company, Inc.
Stamford, Conn. 919

Exhibiting: New Products—3FCD250 frequency changer, electronic source of precision frequency accurate to plus or minus 0.01 percent at 400 cycles or 60 cycles. **Regular Products**—A-c. line voltage regulators; Regulated dc. supplies; Nobatrons.

In Attendance: Edward R. McCarthy, Mgr., Eng. Sales; S. Sterling, H. Crows, H. A. Watson, Jr., Field Engrs.

Southwestern Industrial Electronics Co.
Houston 19, Texas 229

Exhibiting: New Products—Model R Voltmeter, one millivolt full scale ac. and dc., built-in standard cell for instant calibration, input impedance 10 megs, built-in dc. amplifiers, gain of 200 from 0 to 100,000 cps, drift less than 10 millivolts per hour, output will drive 1-ma. recorded. **Regular Products**—Model B power amplifier; Model L. oscillator; Model M-2RC oscillator; Model MB-1 oscillator; Model ML-4 oscillator; Model CRO-1 multichannel cathode-ray recording oscillograph; Model P-2 precision electronic potentiometer; Model C resistance meter; Model G transducifier. Research, development, engineering consultation, special instruments.

In Attendance: Harry J. Girard, V. P., Sales; A. M. Wilkendorf, Sidney Hatchl, Research Engrs.

Spence Engineering Company
Walden, New York 713

Exhibiting: Regulators for accurate control of pressure, temperature, differential, back pressure and liquid level; Pump governors; Electrically controlled regulators; Desuperheaters and strainers.

In Attendance: N. W. Calvert, Sales Rep.; E. E. Miller, C. A. Hunter, W. J. Voss, Sales Engrs.; E. Grafe, Sales Asst.

Standard Electric Time Company
Springfield 2, Mass. 216

Exhibiting: Precision timers and Chrono-tachometers.

In Attendance: E. S. White, Chief Consulting Engr., Timer Division; Herbert P. Blake, V. P.; F. J. Foley, Chicago District Mgr.; L. P. Barsi, Sales Engr.; J. W. Murdock, Columbus Branch Mgr.

Herman H. Sticht Company
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Telechron Department, General Electric Co.
Ashland, Mass. 521

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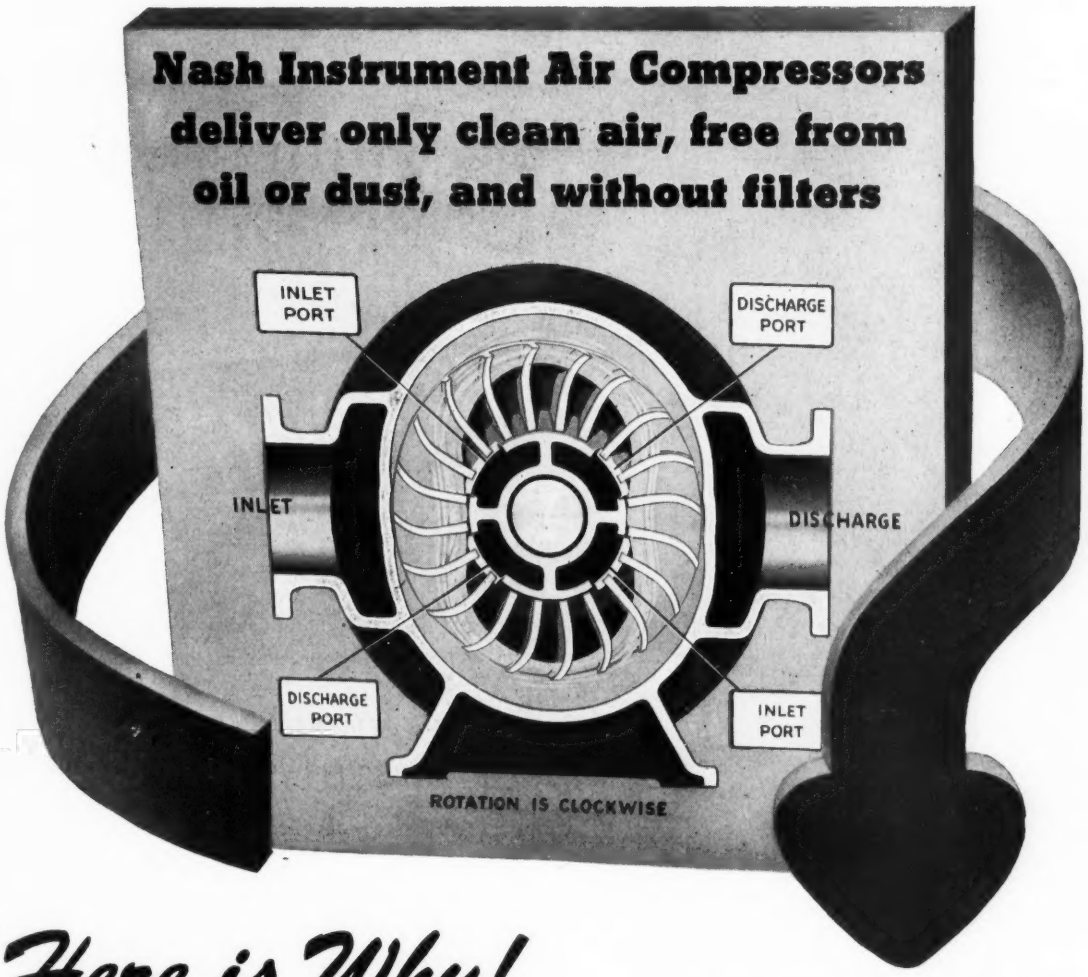

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Hydrostatic Test of Transmission Line

By W. L. MASHETER, Southern Counties Gas Company of California

The experiences and difficulties encountered in hydrostatically testing a 22-inch line with maximum difference in elevation of over 700 feet.

LAST year Southern Counties Gas Company had occasion to test hydrostatically 27,700 feet of 22-inch-O.D. pipeline. The line was constructed of pipe with 7/16-in. wall and was designed for a maximum operating pressure of 1,000 psig. All bends in the pipe were either cold bends with approximately 100-foot radius, shop hot bends with 12-foot radius, or welding ells with 3-diameter (66-inch) radius.

The Pig

In the preliminary planning of the line, a pig with wire brushes was to be used to clean the line after construction was completed. The pig consisted of two sections, each of which was a complete unit. The sections consisted of two rubber cups with wire brushes mounted on arched springs between the rubber cups. The two units were connected by a steel rod to a universal joint in the end of each, making one flexible pig.

When it came time to plan the hydrostatic test, it was decided that these two pigs could be used to push the water from the line. The idea of using the pig ahead of the fill water to expell the air was considered, but was abandoned because water could not be obtained near a point convenient to cut the line.

In the original plan, the pig was to be run through the line once or twice before the hydrostatic test to make sure that the line was clean. By the time the line was nearly completed, the contractor was so far behind schedule that it was decided to combine the scraping and hydrostatic test because the line was needed to increase the amount of gas available for peak loads during cold weather. Our field inspectors assured us that, except for a little dust and dirt, the line was clean—no skids, rabbits, shoes, etc. Therefore, the operation described is for a hydrostatic test only.

Test Preparation

In planning the hydrostatic test, the first step was to make a profile of the line. This was done by locating the line on a topographic map made by the United States Department of Interior Geological Survey. The profile (Fig. 1) was then plotted from the elevations shown on this map. The elevations were field checked at the critical points with an accurate altimeter.

The completed profile showed that the section of line to be tested had a maximum difference in elevation of 728 feet. To keep the maximum difference in hydrostatic pressure to less than 200 psi., the line had to be tested in two sections and a cut was made at Location B, Station 96 + 30.

A shop-fabricated fitting (Fig. 2) was welded to the line at Location A. Two fittings (Fig. 3) were installed at the location of the cut, Location B, and a pig trap identical to the left fitting shown in Fig. 3 was welded to the line at Location C, Station 277 + 00. The two pigs were inserted in their respective fittings in the shop, using glycerine as a lubricant. Both the 2-inch valve and the 4-inch valve were open during the hydrostatic test to equalize the pressure across the pig. A 4-inch valve was installed at Station 261 + 77 to be used for filling the line with water and also for a drain.

The 6-inch blowdown valve on each of the two pig traps was intended to speed up the blowdown of the gas pressure in the line during the scraping operation originally contemplated. When material was ordered six months

September Meeting: Saturday, the 20th, Rio Hondo Country Club, Downey, Calif.

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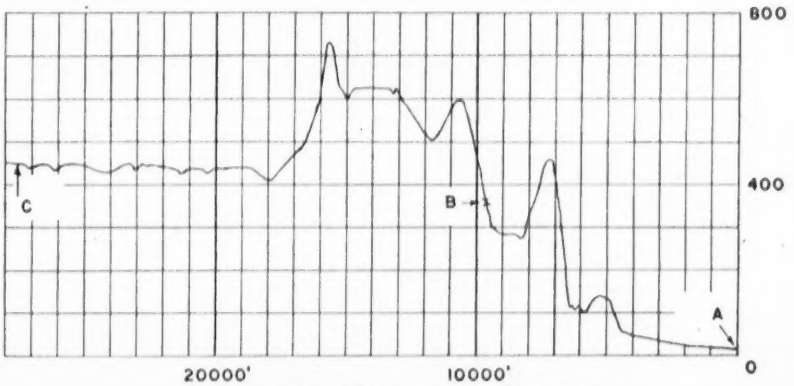

Fig. 1. Plotted profile from elevations shown on map.

Presented at the Pacific Coast Gas Association Transmission Conference, Berkeley, Calif., April 2-3, 1952.

prior to the test, 4-inch valves were selected for discharging the water because they were the largest available and because they were computed to be large enough to discharge water at a rate which would move the pig at the desired velocity—1 to 2 miles per hour.

Twenty-seven vent connections were installed at each of the 27 high points of the line, using 1¼-inch plug valves. The entire line was filled with water because it expedited the hydrostatic test and was more economical than filling one section and re-using the water.

The total capacity of the line was computed to be 510,000 gallons—175,000 gallons for the first section and 335,000 gallons for the second section. The line was filled using the hydrostatic pressure from a storage reservoir with sufficient elevation to overcome the hydrostatic head of the highest point in our line.

A 2,000-psig. pressure-recording gage and a 2,000-psig. indicating gage (check gage) were installed at the points of maximum pressure, Location A and Location B. Also, 2,000-psig. pressure-recording gages were installed at the high points of each section, Station 71 + 74 and Station 158 + 84. A 2,000-psig. pressure-indicating gage was installed on the line near the fill valve. Radio cars for communication were located at the fill valve and at Location A. A high-pressure oil-well cementing pump, mounted on a truck complete with a tank for water supply, was used to pump the water to the desired test pressure. The water tank was supplied by a fire hose from the water source.

A relief valve was installed at the discharge of the pump because unforeseen things or human errors are apt to occur and mechanical safety devices are good insurance. Since a relief valve operating in this pressure range cannot be set closer than ± 10 psig., it was set to relieve at 1385 psig.—equivalent to 1570 psig. at Location A.

Pressure Test

A check was made at 500 psig., 1,000 psig., and 1,500 psig. by radio to recheck the computed differences in pressure between that at the pump and at the lowest point in the line, Location A. The computed difference in pressure checked as closely as the gages could be read. When the pressure reached 1,550 psig. at Location A, the pump was stopped. The pressure gage was watched for approximately 15 minutes and showed no loss in pressure. The two 4-inch valves were closed at Location B and the 4-inch pipe between them removed so that there could be no possible increase in pressure while the second section was being pumped to maximum pressure.

The radio car was moved from Location A to Location B. The setting of the relief valve was increased to 1,540 psig.—equivalent to 1570 psig. at Location B, and the pump started again. The section of line between Location B and Location C was pumped to a pressure of 1,550 psig. at Location B. Up to this point the operation had gone smoothly, the entire pumping operation lasting only two hours and 55 minutes. The hydrostatic test pressure was maintained on the line for five to six hours.

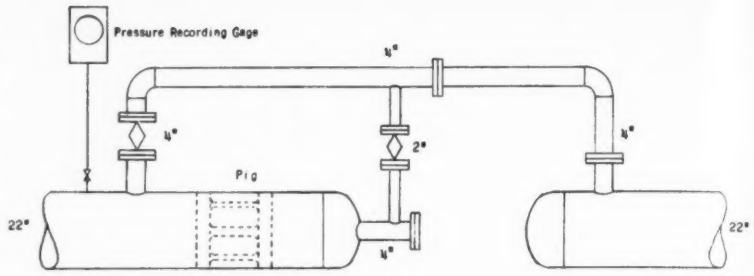

Fig. 2

Removing Water

For the pigging operation to remove the water, the pressure was reduced to 250 psig. maximum at Location A. The pressure at Location B was 95 psig., and 60 psig. on the hill at Station 71 + 74.

A water meter with a maximum rated capacity of 1,200 gallons per minute was connected to the 4-inch valve at Location B and its discharge piped into a nearby stream bed. The purpose of the water meter was to enable a computation to be made of the location of the pig should it become stuck. A radio car for communication was located at Location A and another at Location B.

A valve was located about 10 feet from the end of the 20-inch line to which the new 22-inch line was to be connected. The 20-inch line contained 800 to 900 psig. gas pressure. A 2-inch "Grove Flex-flo" regulator was installed around the closed 20-inch valve and was set to maintain 250 psig.

The 2-inch valve behind the pig was opened and the 4-inch valve at Location B was gradually opened until the discharge rate according to the water meter was approximately 600 gallons per minute. Since several hundred feet of the 22-inch line was uncovered at Location A, we expected to be able to hear the pig move along this portion of the line. The only sound was a grating sound such as would be expected from contact of wire brushes with steel pipe, lasting for maybe a second and then silence. We concluded that the pig was stuck, so we raised the pressure to 350 psig. The pig could not be heard to move, so we tried shutting the water off at Location B and then opening up the valve quickly in an effort to break the pig loose. After trying this a number of times with no apparent success, we decided that the only thing to do was to try to push the water with gas pressure over the first hill so that the line could be opened up at Location A and the pig broken loose with a hydraulic jack or whatever was required. It was computed that 100,000 gallons would empty the line to the crest of the hill. As soon as the water meter read this, the line was shut down, the 4-inch piping assembly removed at Location A, and a stack installed on the 4-inch valve. The line was blown down to atmospheric pressure with no discharge of water during the blowdown operation. A gage connection on top of the 22-inch main then was opened and a stick inserted and only a few inches of water was indicated in the bottom of the line. The 4-inch flange welded to the 22-inch welding head (Fig. 2) was unbolted and, much to our surprise, no pig could be seen!

The line was closed up again and the operation resumed. When the water meter registered the discharge of a total of 124,000 gallons of water, alternate slugs of gas appeared and the operation was shut down.

The water meter was disconnected because it might be damaged by the impact of slugs of water. A 4-inch welding ell and a length of 4-inch pipe were installed on the discharge of the 4-inch valve. The 4-inch valve was fully opened, but after a few minutes of steady flow, alternate slugs of water and gas were discharged. The slugs of gas expanded with considerable noise. Even before this occurred, the pressure had reduced considerably at Location B compared to the gas pressure at Location A plus the computed hydrostatic head, and the discharge of alternate slugs of gas and water seemed to confirm our worst fears that the pig had become stuck and in some manner considerable quantities of gas were leaking past it.

It seemed apparent that nothing was being accomplished with blowing the 4-inch connection, so the operation was shut down again. It was decided that perhaps more blowdown capacity was required and to try the 6-inch valve. As the location was such that no harm could be done by shooting the water and gas straight into the air, time was not expended in piping the 6-inch valve to the stream bed.

With 250-psig. gas pressure at Location A, a brave man donned a raincoat and hat and opened the 6-inch valve. After an initial short blow of gas, water discharged from the 6-inch stack. Eleven minutes later the water turned black, and a few seconds later there was a continuous discharge of gas.

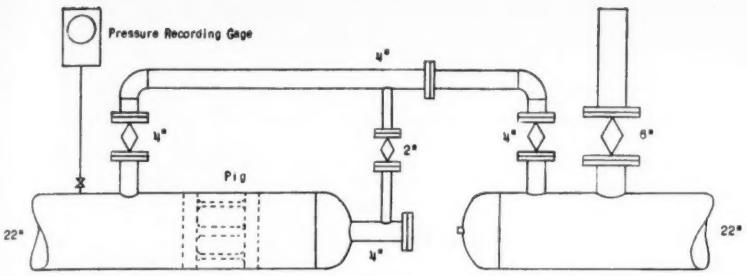

Fig. 3

The gas was turned off at Location A and the gas pressure allowed to blow down to atmospheric pressure. By removing a 1¼-inch plug in a coupling at the end of the 22-inch welding head of the fitting, the pig could be seen with the aid of a flashlight.

The conclusion was reached that the pig should be kept moving faster than was originally planned. Although a 6-inch valve was located at Location C, large quantities of water could not be disposed of at this location. The original plan had been to dispose of the major portion of water at the 4-inch fill valve, Station 261 + 77, leaving approximately 1,600 feet of pipe to be drained at Location C. Therefore, we decided to try the 4-inch valve again with more pressure and no water meter to limit the maximum capacity of the valve. The elevation at the drain valve was 450 feet and the maximum elevation at Station 158 + 84 was 750 feet. The difference (300 feet) was equivalent to approximately 130 psi. Therefore, it was intended not to let the pressure drop below 150 psig. at the drain valve so as not to pull a vacuum on the section between it and Station 158 + 84.

After about an hour and 45 minutes of draining operation with 300-psig. gas pressure, difficulty was experienced in maintaining 150 psig. at the drain valve. The gas pressure was raised to 400 psig., the maximum discharge pressure of the regulator. After 2½ hours had elapsed, the pressure at the drain valve dropped below 130 psig.; although this was undesirable, there seemed to be nothing to do but to continue the draining operation at that pressure. One time the pressure dropped as low as 85 psig. About 4½ hours after the start of the run, gas appeared at the discharge pipe in the form of a slug of gas followed by a slug of water, as had occurred in the first section.

To obtain a larger discharge connection, the line was blown down so that, at Station 257 + 27, the pressure was a few inches of water column. The 1¼-inch air-vent valve at this point was opened, and a stick was used to confirm that there was no water in the line at this point. A 6-inch hole was cut in the top of the line with a welding torch, using a fire stack to control the fire. A 6-inch flanged nipple was welded to the line and a 6-inch plug valve was bolted to this flange with a 6-inch stack approximately 10-feet high.

A radio car was stationed at the gas supply at Location B and another one at the 6-inch drain valve. A man was stationed at the 4-inch drain valve at Station 261 + 77, where he could see a hand signal given at the 6-inch valve. He could communicate by radio ("Handie-Talkie") with another man at the end of the line where the outlet of the 4-inch valve had been piped into a small stream bed. With about 250-psig. gas pressure at Location B, the 6-inch valve at Station 257 + 27 was fully opened. After a short blow of gas, a geyser of water appeared and continued with an occasional slug of gas for about 30 minutes. The moment the water turned dirty (black), the two men at the 4-inch valves were signalled to open them. About 30 seconds later only gas discharged from the 6-inch stack and the 6-inch valve was immediately closed.

About ten minutes later, gas appeared at the 4-inch valve at Station 261 + 77 and this valve was closed. The man stationed at this valve stated that he heard a scraping noise which he was pretty sure was the pig passing by. Several hundred feet of the 22-inch pipe had been left uncovered ahead of Location C, and about 15 minutes later the pig could be heard moving toward this uncovered section. The sound was much like that of a steam locomotive in the distance. The sound kept increasing and in about two minutes reached a maximum at the beginning of the uncovered section. I followed the sound at a slow walk for the remaining distance to the pig trap.

Inspection of both pigs after they were removed from the line showed grooves in the first cup such as would be expected when gas is bypassing at high velocity. As the pigs had been designed for cleaning rather than displacing water from a line, only the first cup made the seal to push the pig along. The body of the pig between the first and second cups was slotted to allow foreign material scraped from the pipe by the brushes to be blown ahead of the pig.

We had a 1¼-inch test connection at a low point along the line and, after the line had been blown down, a stick indicated no water in the bottom of the line. Also, no water was found in the line at Location B and very little at Location A. We were rather surprised at this because we expected that the delays and leakage of gas past the pig probably resulted in a rather poor displacement job. Two days later, when we started to make the tie-in at Location A, the line was found ½ full of water at this point. An estimated 1,000 gallons were pumped out. We were never able to completely explain this condition except that water apparently had drained from the walls of the approximately one-mile length of pipe which gradually sloped up from this point.

A leg-type drip was installed at Location A as part of the permanent installation of the line. This drip was installed to remove condensate which sometimes appears in a line operating at high pressure because of the retrograde phenomenon. As the line had to be put into service as soon as possible, it seemed more expedient to use this drip to catch any remaining water rather than take time to run the pig again.

The load on the 22-inch line was increased gradually over a period of about a week (it would have been increased faster if the gas were needed) to approximately 250 million per day. During this period, the drip was checked regularly. The operating personnel in the Santa Barbara Division estimated that they drained approximately 3,000 gallons from the drip. Checks on the 20-inch line into which the 22-inch line was connected showed no indications of carryover of water.

Conclusion

The conclusion, based on our experience, was that most of the difficulties encountered would have been avoided if 6-inch valves and piping had been used for discharging the water instead of 4-inch valves and piping. Possibly, if the pig had been of the displacement type, with two or more cups to seal the gas pressure from the water, it could have been moved at the slower rate with no difficulty.

Our theory regarding the pigs becoming stuck is that in moving at the slow rate along the line, the rear working cup found a position in one of the short-radius turns (3-radius welding ells) at which it would bypass considerable gas. Sufficient differential then could not be built across the pig with the maximum discharge rate from a 4-inch to move it. The one incident for which we have no explanation is why we did not hear the pig start in the first section. In all other places where the pipe was exposed, the movement of the pig could be heard quite plainly.

In reviewing the operation and difficulties encountered, it must be concluded that the operation was successful; although at several points in the operation, we had some doubts. Another conclusion was that the most careful planning is none too good for a job like this, and that radio communication is indispensable.

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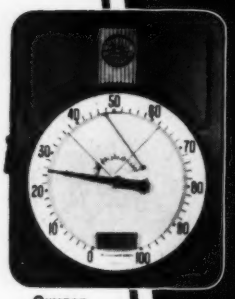

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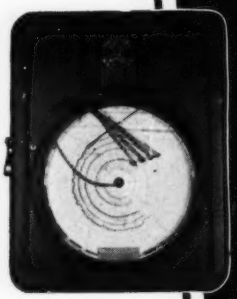

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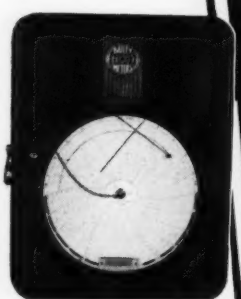

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VALVE RANGEABILITY

Continued from page 1079

what simplified. Maximum capacity, or the area of the seat, increases as the square of the diameter, whereas the leakage flow, or clearance, increases directly proportional to the diameter.

On 2-inch valves and smaller valves the problem of maintaining small leakage flow on double-seated valves becomes increasingly difficult; in ¾-inch sizes or smaller, the use of double-seated valves is generally impractical where wide flow ranges are required. This is because as the seat-ring size is reduced, the reduction in area is a function of the square of the diameter, whereas the circumference is reduced only as a direct function of the diameter. To further complicate the problem the relatively large plug-post diameter in smaller valves results in a much smaller free seat area. This means that oversized rings are required to obtain maximum capacity, resulting in a larger percentage leakage flow and reducing the flow range.

The use of single-seated valves without bottom guiding in valve sizes below 1 inch provides a good compromise to keep the leakage flow to a minimum and thus obtain a reasonably good flow range.

Maximum Flow, or Rated C_v

The determination of the optimum maximum capacity of a given size valve (the rated C_v) is a complex subject. Any approach to the problem may be reasonably sound within a narrow set of operating conditions. Consideration of the rated capacity involves a wide variety of services with C_v ratings from 0.1 to 3000, and valves suitable for pressure drops from less than 1-inch H_2O to 10,000 psi. Therefore, let us restrict our consideration to valves of sizes ¾ inch to 14 inches, designed for use on pressure drops between 1 and 500 psi., and with conventional single- and double-seated construction. This limits the discussion to a general-purpose valve used extensively by the process industries for throttling services.

The question that immediately arises is: "What is the optimum C_v of a given valve?" Consideration must be based on the end use of the valve. It may have a constant pressure drop of 2 psi. or 400 psi. On the other hand the drop may vary widely with the flow. It may be used on liquids or flashing liquids, or on compressible fluids up to and exceeding the critical pressure ratio; sometimes in series with a high drop or often with negligible drop, with short connecting piping or, in the case of oil pipe lines, in series with 50 miles of pipe. Although good practice usually dictates swedge connections to lines larger than the valve size, many installations are made line size or installed in by-passes of line size. In other words, the valve may control flow under a wide variety of service conditions.

What criterion can we use in establishing the optimum C_v? The present trend is toward high C_v ratings, the inference being that a high C_v rating is one of the essential ingredients of a good valve. This necessitates more consideration in installation so that the higher flow ratings are realized in actual service. Smaller C_v ratings for given sizes might necessitate use of larger valves and a higher net investment.

The valve with a lower C_v rating is less critical to install and in many instances provides better performance. This is especially true for general-purpose valves when used on flashing liquid and compressible fluids under high pressure drops.

One criterion to determine C_v rating is *body velocity*. If narrow limitations were imposed, this approach would set the C_v rating as a function of the pressure drop. This would involve a series of special trim with graduated C_v ratings or, in other words, a custom-made valve—not an all-purpose valve.

This establishment of optimum C_v is an industry problem and it would be desirable to establish standard optimum C_v ratings for all sizes of conventional control valves.

The idea has been advanced to limit the rangeability ratio to a percentage of the lift or a percentage of the flow. This approach may have merit from an application

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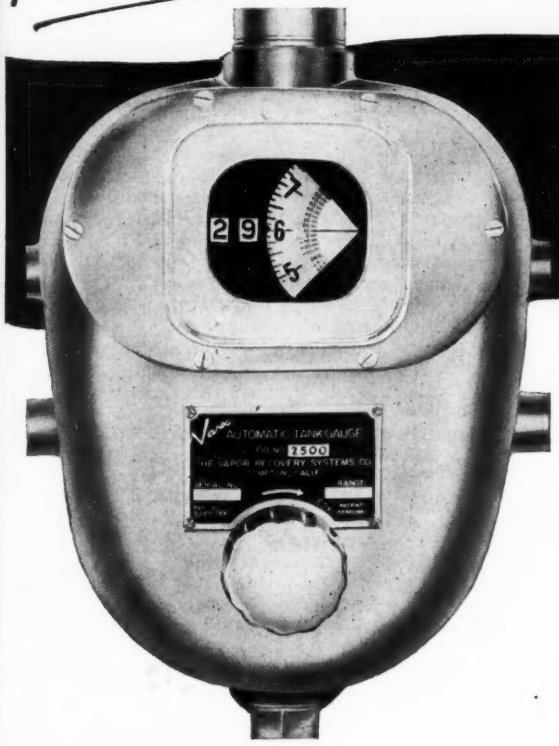

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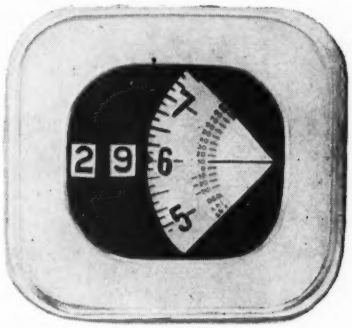

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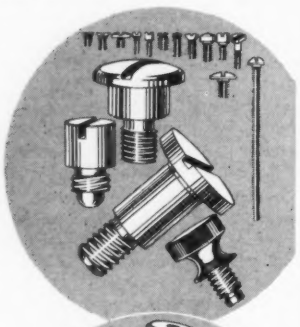

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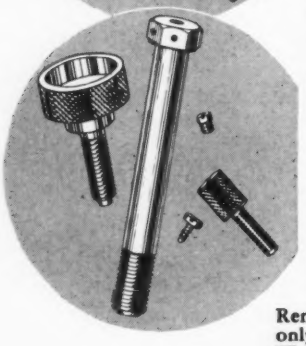

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viewpoint. This may be desirable to compensate for the reduction in the ratio due to system drop in series with the valves. However, if rangeability is a property of the valve only, then the full valve rangeability ratio should be specified, limited only by the mechanical design and flow efficiency of the valve passages.

The linear valve exposes port area at a uniform rate and a given linear valve can expose a larger port area than a perfect equal-percentage valve. In most instances the port area available is so large with respect to inlet and outlet area that it is impractical in the design of a linear valve to utilize the additional area. For all general requirements the capacity of the equal-percentage and the linear valve should be considered equal.

Conclusions

The present definition of rangeability has little basic meaning in spite of the fact that the term is accepted and used widely in an attempt to describe an inherent property of a control valve. There are three factors which must be used to define rangeability—(1) maximum controllable flow, (2) minimum controllable flow, and (3) flow characteristics. None of these factors are defined adequately today.

The maximum controllable flow, or rated C_v, for any general-purpose valve is probably a function of the system in which it is to be installed. The industry should set up basic standards for testing and then adopt industry-wide standard C_v ratings.

The minimum controllable flow must be defined more rigorously. It is possible to determine this on percent of maximum flow or percent of valve lift, but some allowance should be made for small valves and low-stroke valves.

Little work has been done to clarify valve flow characteristics. For the equal-percentage valve, *unit sensitivity* (percentage flow change for 1-percent change in lift) suggests an excellent approach to the problem. The 50-to-1 equal-percentage valve then becomes a 4-percent valve, and it may be feasible to establish limits of slope change on commercial valves. If "unit sensitivity" limits were set up, the flow range (maximum to minimum) then would be determined by both the permissible slope change and the mechanical design factors of the valve.

Contrary to general belief, commercial valves are available today with approximate equal-percentage characteristics with a flow range of 50 to 1. The actual flow characteristics are not perfect, but at the present time there is no accepted method for quantitatively analyzing the flow behaviour deviation with respect to the ideal.

Acknowledgements

The author is indebted to Mr. Paul Wing, Jr. of the Mason-Neilan Regulator Company for aid in preparation of this material and providing the appendix; Mr. J. B. McMahon, Republic Flow Meter Company; Mr. Ivan Thomas & Mr. Ralph Webb, Carbide & Carbon Chemicals Company; Mr. Walter Bowers, The Standard Oil Company of Ohio; and Mr. C. E. Mason for their comments and helpful discussions.

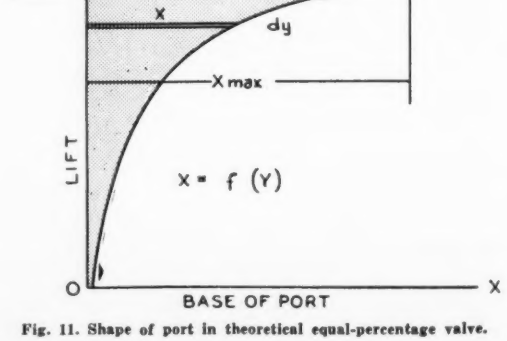

Fig. 11. Shape of port in theoretical equal-percentage valve.

Appendix

The mathematical equations for determining the contours of a theoretical equal-percentage port, together with the development of the expression for R_{math} are given here for reference purposes.

The general equation of effective area vs. lift for any valve having equal-percentage characteristics is as follows:

$$A = be^{aY} \tag{1}$$

Where A = effective area in square inches
Y = lift in inches
a & b = constants, the value of which may be determined as follows:

From (1) $$b = \frac{A}{e^{aY}} \tag{2}$$

When $Y=0$, $$b = \frac{A_o}{e^{a(0)}} = A_o \text{ since } e^0 = 1 \tag{3}$$

where A_o = value of A when $Y = 0$

From (1) $$\frac{A}{b} = e^{aY} \text{ or } \log_e \frac{A}{b} = aY \tag{4}$$

From (4) $$a = \frac{\log_e \frac{A}{b}}{Y} \tag{5}$$

From (3) & (5) $$a = \frac{\log_e \frac{A}{A_o}}{Y} \text{ or} \tag{6}$$

Since $Y = Y_{max}$ when $A = A_{max}$

$$a = \frac{\log_e \frac{A_{max}}{A_o}}{Y_{max}} \tag{7}$$

The ratio A_{max}/A_o is the ratio of the maximum to the minimum area through which equal-percentage characteristics are maintained and is designated by the term R denoting rangeability.

$$\therefore a = \frac{\log_e R}{Y_{max}} \tag{8}$$

From (1), (3), & (8)

$$A = A_o e^{\frac{\log_e R}{Y_{max}} Y} \tag{9}$$

The problem now is to determine a curve $X = f(Y)$ corresponding to the shape of the ports in a skirted-type valve which will give a developed area fitting the general equation (9) for the equal-percentage valve. This curve is shown in Fig. 11. The shaded area represents the port in the skirt.

The total shaded area is equal to the sum of an infinite number of small rectangles, one of which may be designated by XdY where dY is an infinitesimally small distance along the Y axis between zero and maximum lift.

Mathematically this is equivalent to saying

$$A = \int_{Y_o}^{Y_{max}} x\,dy \text{ or } dA = x\,dY \tag{10}$$

By rearrangement: $\frac{dA}{dY} = X =$ width of base of port at any lift. (11)

In Equation (1) $$A = be^{aY} \tag{12}$$

$$\therefore \frac{dA}{dY} = X = abe^{aY} \tag{13}$$

The curve of the base of port of valve therefore plots as a straight line on semi-log paper parallel to the final area curve displaced on the plot by the constant a.

If in a skirted-type valve, equal-percentage ports are to

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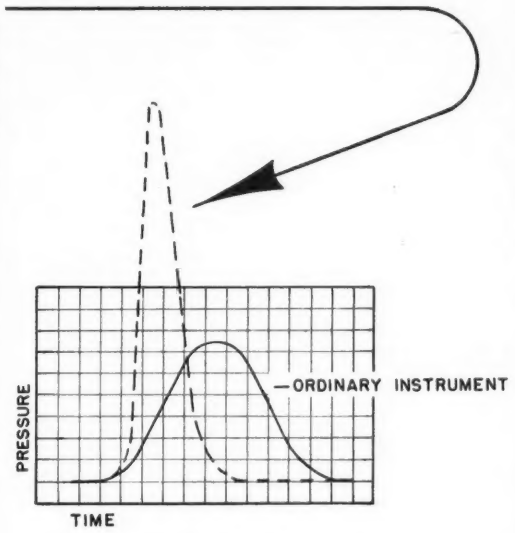

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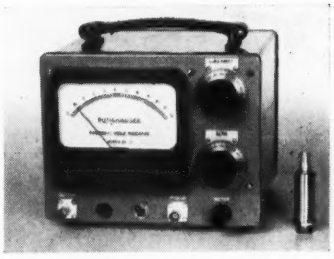

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be designed to utilize full skirt circumference, then X_{max} becomes the circumference of the skirt or skirts.

From (13) $$X_{max} = abe^{aY_{max}} \quad (14)$$

From (8) & (14) $$X_{max} = abe^{\log_e R} \quad (15)$$

But $$e^{\log_e R} = R \quad (16)$$

$$\therefore \quad X_{max} = abR \quad (17)$$

$$X_{max} = \frac{\log_e R}{Y_{max}} A_o R \quad (18)$$

Since $$A_{max} = A_o R \quad (19)$$

$$\therefore \quad \text{From (18) \& (19)} \quad \log_e R = \frac{X_{max}\, Y_{max}}{A_{max}} \quad (20)$$

or R_{math} = the number whose natural logarithm =

$$\frac{\text{total seat circumference} \times \text{rated lift}}{\text{maximum port area}}$$

INSTRUMENT DEPARTMENTS

Continued from page 1085

the basis of tests and interviews. Most applicants for the mechanic helper group come from the plant. When selected for the Instrument Division, helpers normally enter a formal training program which consists of four hours of training per day, five days per week, for periods up to six months. The training is handled by various engineers and supervisors, no single individual serving as a permanent trainer. In addition to the formal training program, area training is given as needed when new equipment is installed or when additional men are needed with specific types of training. This training, along with the actual work experience obtained while working with mechanics, is the principal means for a man becoming qualified for advancement to mechanic. To become a mechanic an opening must occur in that group, and advancement within that group from third to first class then depends on a man's increase in qualification and skill, with no time limit.

There is a training and development program for the instrument engineers. This consists of (1) trips to various society meetings and to special courses and seminars and (2) a two-hour seminar held one evening each week. At these seminars topics of special interest to the engineers are discussed.

Shops.—The Instrument Division has a well equipped central shop. In addition, there are six area shops out of which work most of the instrument area mechanics. All types of shop work are carried on. The central shop is equipped to handle valve and electronic work primarily, with regular instrument maintenance being carried out in the area shops. The Instrument Division handles no safety valves and nothing that is not process instrumentation. Laboratory instruments have not been served in the past because of the lack of manpower, but the Division is beginning to assist the laboratory and plans ultimately to service instruments and spectrometers on the same basis as it does those in the plant.

There are no specialists in the organization. Each man is required to have a major skill and general skills. Groups may be trained to handle special work, but when such training is needed, more men are trained than would be required on a minimum basis. Thus an ample work force trained in the specific work is available.

Much specific *development work* is carried out by the organization at Orange. However, research in the general field of instrumentation is carried on by the Engineering Research Laboratory at the du Pont Laboratory in Wilmington, Delaware. Field testing of any instruments is carried on as required in the plant without commitment on the part of the plant to purchase and retain the instrument which is being tested.

There are two major annual conferences which are participated in by personnel from the Sabine River Works. One of these is an annual company-wide instrument seminar

at which all plants as well as engineering, technical and research organizations are represented. The second is the departmental seminar at which representatives of plants having similar interest meet. Various committees, which are a part of this over-all organization, work in special fields and on special problems. These committees report at the annual seminar meetings; the reports are given by representatives of the various segments of the organization on special problems and developments of interest.

Monsanto Chemical Company, Texas Division, Texas City, Texas

Monsanto at Texas City is a medium-sized chemical-manufacturing plant. Its major product in the past has been styrene monomer, but extensive new facilities for the production of acrylonitrile are being added.

The organization setup is shown in Fig. 4. This organization deviates sharply from the conventional pattern in that the instrument department is a part of the process organization rather than the mechanical department. It

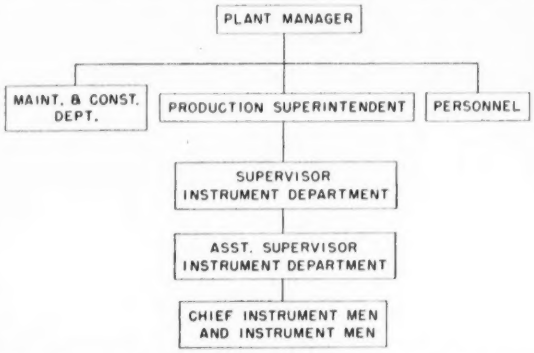

Fig. 4. Organization of the Monsanto Chemical Co., Texas City, Texas.

is one of about ten major process departments or units that report to the Production Superintendent. This arrangement stresses the concept of instrumentation as a closely integrated factor in operations. Moreover, the organization has the advantage of compactness, which contributes to smooth and efficient operation.

There are 28 men in the department, including the Supervisor, Assistant Supervisor, seven chief instrument men, who are working group leaders, and nineteen instrument men. New men are usually employed directly into the department, although there are occasional transfers from other departments.

On-the-job training is given, with especial emphasis on process operations. Training is done by the supervisors, the chief instrument men and sometimes by representatives of instrument manufacturers. Actual work and classroom instruction are used in training. Each instrument man is expected to be thoroughly familiar with the process flow on units upon which he has been trained. All of the men are rotated in their field assignments so that each can become well trained in the maintenance of all plant instrumentation. There are no specialists and no restrictions on the type of work that can be done by any individual.

Preventive maintenance is a routine assignment. Costs are distributed to the operating departments based on the instrument-department labor distribution. Overhead is prorated on labor; materials are coded directly to the operating department involved. Trouble-shooting is done in cooperation with operating personnel. Operating supervisors coordinate but do not direct the work of instrument men.

The *instrument shop*, which is roomy and pleasant, is equipped with small machine tools and any machine work that is not too large for the equipment is done there by members of the instrument department. Large orifice plates, for example, are sent to the plant machine shop.

New construction is designed by the general engineering department. The instrument department influences the selection of instruments and their arrangement in the unit. In-

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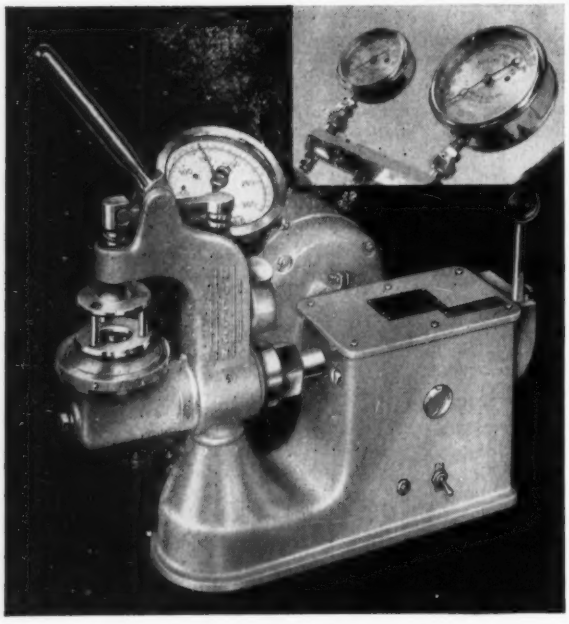

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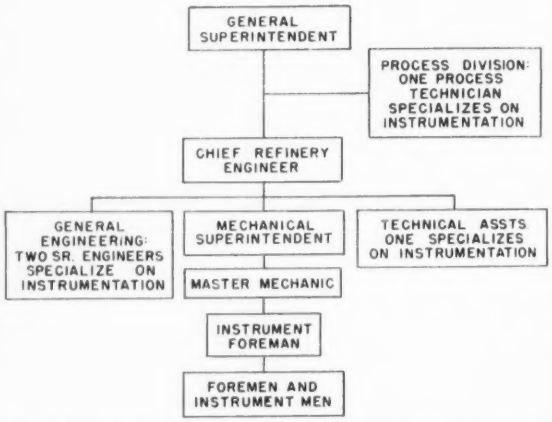
stallation of instruments by contractors on new construction is followed by the instrument department personnel.

Electronic instruments are maintained normally by chief instrument men. Laboratory instruments are serviced in the same manner as those in the plant.

Cities Service Refining Corporation, The Tutwiler Refinery, Lake Charles, Louisiana

Cities Service at Lake Charles is a new, modern petroleum refinery, which was placed in operation in 1944. It is currently charging about 165,000 barrels per day. However, it is primarily a fuel-products plant and does not engage in the manufacture of a diversity of special products.

As shown in Fig. 5, all mechanical and engineering activities are under the direction of the Chief Refinery Engineer; this arrangement makes for close integration of engineering and mechanical maintenance work. The 57 employees of the instrument department include the Instrument Foreman, 5 Mechanical Foremen, 34 instrument men, and 17 helpers. New employees are trained as helpers and remain in this classification until openings occur, when promotion to instrument man is made by seniority rules.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TECHNICAL ASSTS ONE SPECIALIZES ON INSTRUMENTATION
MASTER MECHANIC
INSTRUMENT FOREMAN
FOREMEN AND INSTRUMENT MEN

Fig. 5. Organization of the Cities Service Refining Corp., Lake Charles, La.

There is a considerable number of staff personnel who are active in the field in instrumentation. One of a group of engineers who assist the Chief Refinery Engineer in a staff capacity is assigned full time to instrumentation. He follows new developments, and assists in selection of new instruments and in instrument design. A Process Technician on the staff of the Process Superintendent is highly skilled in instrumentation and is consulted on all phases of process instrumentation. Two Senior Engineers in the General Engineering Division are specialists in instrumentation and participate in this aspect of all projects. The Process Engineering Division is active to a limited extent on instrumentation of new installations. Thus there is available a group of staff technologists with varied backgrounds and viewpoints to assist in selecting, installing, and maintaining the instrumentation of the plant.

When a new installation is to be designed it is assigned to a design engineer in the General Engineering Division. The initial instrumentation design is handled by the specialists in that division. It then is reviewed by the various staff personnel mentioned previously, and by the instrument foreman. Final specifications are written by the general engineering division specialists.

A large part of new construction is done normally by contractors, but all installation of new instruments is done by the instrument department and not by the contractors.

The instrument shop personnel operate no machine tools except a drill press. Lathe work is done by the machine shop.

Spectrometers in the laboratory are maintained by laboratory personnel. However, all other laboratory instruments are maintained by the instrument department.

ESSO STANDARD OIL COMPANY, LOUISIANA DIVISION
M. & I. DIVISION OF M. & C. DEPARTMENT
BATON ROUGE, LOUISIANA

The refinery of Esso Standard at Baton Rouge is one of the largest in the United States, currently charging about 250,000 barrels of crude oil per day. It manufactures fuel products, many petrochemical products, and specialties. The magnitude and complexity of the operations require an instrument department organization that is correspondingly large. The personnel number some 165 men (Fig. 6). The Superintendent, Mechanical Division, reports to the Assistant General Superintendent, as do the superintendents of the other major divisions of the organization. He, in turn, reports, through the General Superintendent and Assistant General Manager, to the Vice-President and General Manager.

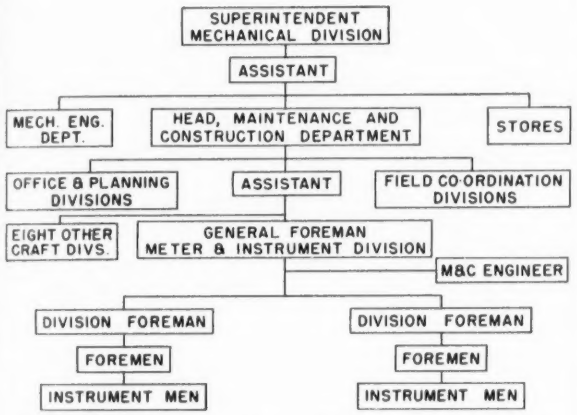

Fig. 6. Organization of Baton Rouge Refinery, Esso Standard Oil Co.

In order to clarify the organizational structure of the Meter and Instrument Division, it should be mentioned that for Maintenance and Construction Department organization the entire refinery is divided into four field coordination divisions. Divisions 1, 2, and 3 include major processing groups; Division 4 includes all general plant and service facilities such as shops, buildings, roads, laboratories, etc.

The present personnel of the Meter and Instrument Division comprises 10 salaried people and 154 wage earners. Of the latter, 131 are "Combination Instrument Men," 22 are apprentices recently transferred in a group from other crafts, and one is the shop porter. A "Combination Instrument Man" is an Instrument Journeyman trained to install and maintain both mechanical and electrical instruments, including air-actuated and electrically-actuated transmission systems, pneumatic control systems, electronic instruments, displacement meters, etc. There are no people in the "inspector" or "second class" classifications at present.

The Meter and Instrument Division is headed by a General Foreman, assisted by a Maintenance and Construction Engineer who is assigned to the division as technical assistant, but is not on the division's roll. Reporting directly to the General Foreman are two Division Foremen. One of these is in charge of the work in Nos. 1, 2 and 4 Divisions (of the refinery). The other has No. 3 Division, which is separated geographically from the other three.

Five *First Line Foremen* report to the first of these Division Foremen, and two to the other. Each of these men is assigned to a certain area. Of the first group, one is assigned all of Division 1, two are assigned to Division 2, one is assigned to apprentice training, and one—assigned to Division 4—is the Shop Foreman who handles not only No. 4 Division, but is responsible for 12 shift mechanics who are assigned to specific areas. Each First Line Foreman has from 21 to 31 men, including shift men.

In the "Area Supervision" system used at the Baton Rouge Refinery, some of the craftsmen of most crafts are assigned to specific units or groups and receive their orders directly from the Area Supervisors on the units to which

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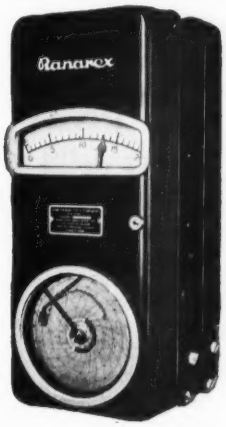

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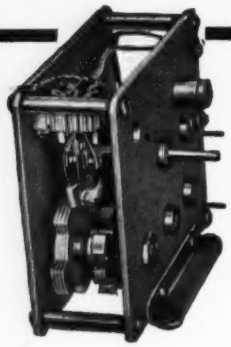

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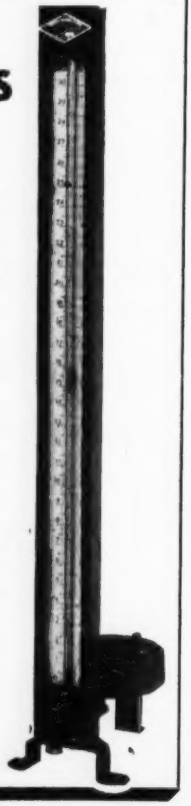

they are assigned. The First Line Foreman's main duties are to handle timekeeping, personnel problems, job assignments, and the supervision of men not regularly assigned. First Line Foreman's main duties also include craft worker performance, craft "know-how," apprentice, and on-the-job training. It is necessary for him to assist in the procurement of materials. He is also available to consult with any of his men or the Area Supervisors on instrument problems.

New employees are selected from among applicants from other departments on the basis of tests and interviews and are placed in a four-year apprentice-training program. Training is formal and is carried out by the Training Department with the assistance of an instrument department supervisor. Mock-ups of typical instrument installations are available for study. Upon completion of training, the apprentice becomes a Combination Instrument Man and establishes seniority in the classification. He remains in this classification if the work requirement justifies it, otherwise he may be classified as 2nd Class Instrument Man.

The instrument department installs and maintains all instruments in the refinery. These include conventional indicators, recorders, and controllers, and also specialized instruments such as calorimeters, density recorders, pH recorders, supersonic sounding equipment, remote tank gages, and spectrometers. Mass spectrometers are serviced on commercial scale operating equipment; laboratory spectrometers are serviced by laboratory personnel. The department does not maintain safety valves, water coolers, specialized laboratory equipment, air conditioning, telephones, radio communication, or public-address systems. (It may also be of interest that the Meter and Instrument people do not change circular charts. These charts are changed by process people and Yield & Cost people, and orifice calculations and chart computations are made by the Yield & Cost group. Strip-roll charts, however, are changed by the Meter and Instrument Division.)

Preventive maintenance is a routine assignment. Nonroutine repairs and minor additions or replacements are worked out through the combined efforts of operating and instrument personnel and various staff personnel, including engineers in the technical service organizations. More extensive jobs are usually initiated in the technical service divisions and designed by specialists in the Mechanical Engineering Department. The instrument department is consulted regarding selection of instruments and specifications, but does not ordinarily review final specifications and drawings before issue.

Major projects are engineered by Esso Engineering Division, Standard Oil Development Company at Elizabeth, New Jersey, an organization which serves a number of subsidiaries and affiliates of Standard Oil Company (N.J.). Every opportunity is afforded for consultation with the project engineers of Esso Engineering, and the proposed instrument specifications are reviewed by the Meter and Instrument Department before they are finalized. During actual construction, the department is responsible for following the contractor's work to see that it meets specifications.

The department has a large shop, well equipped with small tools. All machine work is sent to the refinery shops. Two pick-up trucks, radio-equipped and stocked with parts, are provided.

As would be expected in an organization of such complexity and size, emphasis is placed upon cooperative effort. Frequent and cordial personal contacts are maintained between appropriate supervisors in mechanical, process, and engineering and technical groups. The department serves the Yield & Cost Department in a vital capacity in maintaining the metering equipment at maximum accuracy, and mutual cooperation is essential between the two groups. Close cooperation between the instrument man and his supervisors, the mechanics and foremen of other crafts, the area supervisors and division engineers, and other service groups is considered a major responsibility of the organization.

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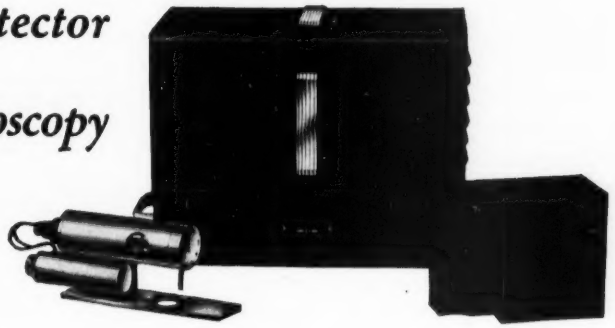

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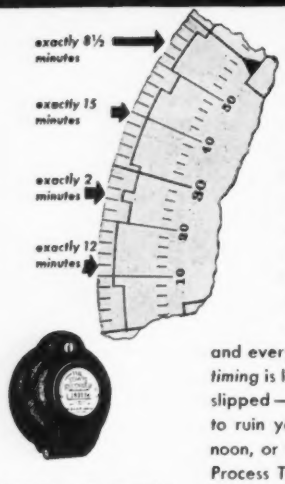

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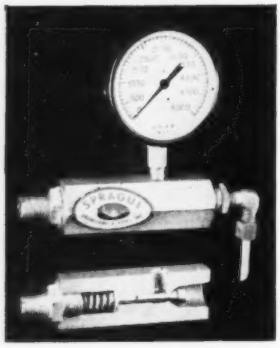

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in the petroleum-refining industry, processing about 260,000 barrels of crude per day. In addition to conventional fuel products, it manufactures large volumes of solvents, lubricating oils, and selected hydrocarbons.

The Instrument Department (Fig. 7) is a correspondingly large organization of 146 employees, of which 21 are salaried. The department is set up as a craft within the Maintenance and Construction Division, the Instrument Department Foreman reporting to an Asst. Superintendent, Maintenance and Construction; he, in turn, reports, through the Superintendent, Maintenance and Construction, the Asst. Mechanical Superintendent, the Mechanical Superintendent and the General Superintendent, to the Plants Manager. It is a "line and staff" organization. The staff

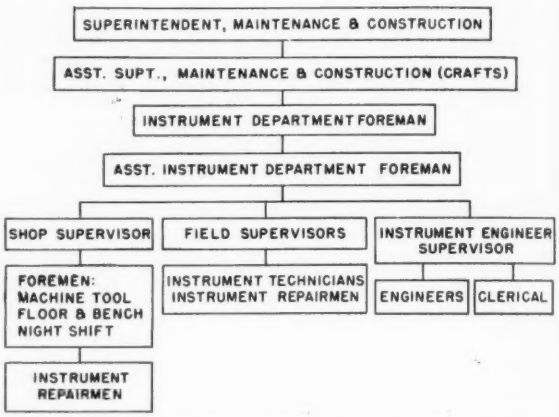

Fig. 7. Organization of Humble Oil & Refining Co., Baytown, Texas.

organization comprises a supervising engineer, three engineers, and five clerks. This group is available for consultation with the Instrument Supervisors on instrumentation problems, with the Refinery Accounting Department on metering and yields, and with the Process Design and Mechanical Engineering Divisions on the design of new installations. Design is handled by the last group, rather than by the instrument engineers. The instrument engineering supervisor is responsible for training and safety programs, for the maintenance of spare parts and instrument stocks, and for the files on instrument calculations, installations, and field performance.

The *line organization* is divided into two major sections, shop and field. In addition there is a small "special instruments" group. The shop is large, modern and completely equipped, even to machine tools. The shop space covers 16,000 sq. ft. of the air-conditioned central shop building. There are 13 employees who spend full time in operation of machine tools. Instrument maintenance in the Baytown plant is built around the shop organization, and in this respect differs from most other organizations of its kind. Including the machine-tool operators, shop personnel averages between 35 and 45 men. Those not on machine tools are doing what is known as the "floor and bench" work, and electrical and electronic work in the "field" line of promotion.

For *field instrument maintenance*, and to take care of new construction, whether done by the company or outside contractors, the refinery is divided into five zones with a supervisor assigned to each zone. The zones are subdivided into areas with an Instrument Technician assigned to each area. The Technician is responsible for routine maintenance and construction work that involves instruments in his area. He may work alone or with several Instrument Repairmen, 1st Class, or trainees, depending on the number of instruments and the geographical arrangement of his area.

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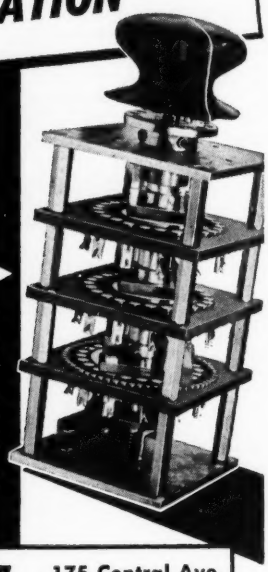

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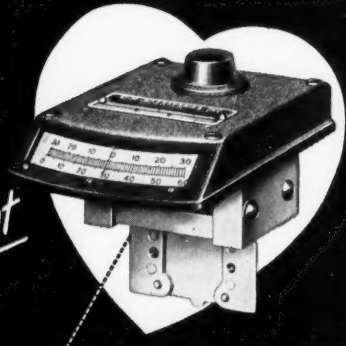

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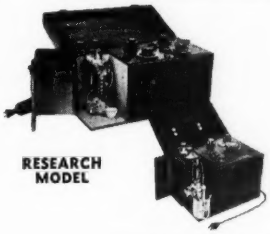

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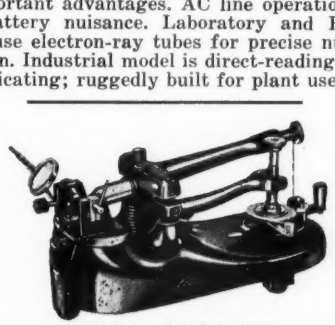

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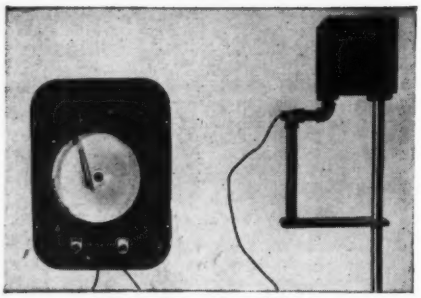

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The Instrument Supervisor works alongside the other craft supervisors in his zone. The work in each zone is coordinated by Mechanical Zone Supervisors. Emergency work is covered by three men per shift around the clock.

The special instruments group consists of only two men at present; these employees are assigned to work with the physical measurements research group in the laboratory, where they maintain mass spectrometers and other spectrographic instruments.

The work coverage by the Baytown organizations is broad. In addition to the maintenance of process control instruments, the department tests and repairs safety valves, does all control-valve work except machine work too large for a 20-inch lathe, and a number of minor "nuisance" jobs such as repairs to locks, clocks, and some office machinery. The Machine Section builds many types of specialized apparatus for the control, testing, and research laboratories.

An Instrument Technician is assigned to a new unit under construction, whether by Humble or by outside contractors. Where work is done by contractors the Baytown Instrument Department inspects the installations, makes final checks on calibration, and assists in putting the unit into operation.

New employees are brought into the Department by transfer, mainly from other mechanical groups, with selection based entirely on the recommendation of the Department Foreman. The Process Department has been a source of good instrument men (who have had to take a reduction in pay to enter the department). Since 1944 minimum entrance requirements have included a battery of psychological and aptitude tests. The Department has been fortunate in being able to maintain a backlog of qualified applicants.

Under the present training program, trainees advance to 2nd Class on floor and bench work in the shop. Their training continues on field assignments and they are eligible for promotion to 1st Class upon the accumulation of one year on field assignments. With the exception of men in training, all field work is done by Instrument Technicians and Instrument Repairmen, 1st.

The practice of rotation of men is followed as far as possible. Increased use of special analytical instruments tends to limit the men who can be assigned to certain units; however, rotation of assignments is limited only by the ability of the instrument man.

Shell Oil Company, Houston Refinery

The Shell refinery is a large unit in the industry, currently charging about 125,000 barrels per day. It produces a full line of petroleum products and a considerable volume of petrochemical raw materials. This description covers the refinery only.

Responsibility for instrumentation is divided between two groups, the Instrument Engineering Division and the Instrument Department proper. As shown in Fig. 8, the Chief Instrument Engineer reports to the Assistant Chief Engineer (Office), whereas the Instrument Department Foreman reports to the Master Mechanic. Common supervision is in the hands of the Chief Engineer to whom the

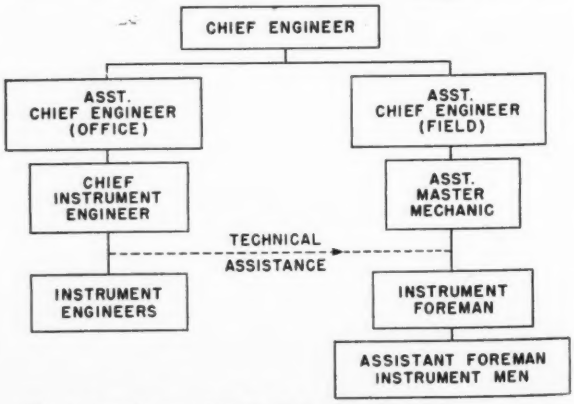

Fig. 8. Organization of Shell Oil Co., Houston, Refinery.

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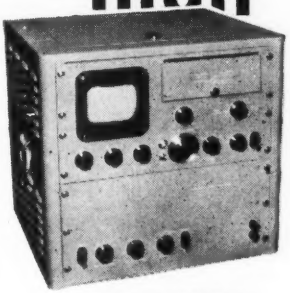

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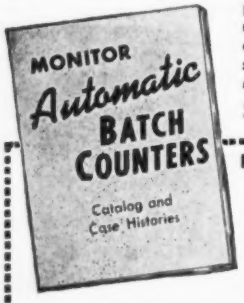

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two Assistants report. The organization and functions of the two groups are discussed separately.

The *Instrument Engineering Division* has, under the Chief Instrument Engineer, five engineers and one clerk. Engineers for this group may be graduates in mechanical, electrical, or chemical engineering. They are assigned to operating areas, and are required to have a knowledge of the process operations in their areas. They work in close cooperation with Technical Assistants who are engineers from the Technological Department assigned to the same areas. Instrument engineers are not directly concerned with routine maintenance; however, high-maintenance instruments or special problems are handled by this group. They assist operators and technologists in the solution of yield and material balance problems. They work up training programs for instrument mechanics; however, the actual training is usually done by the Instrument Department Shop Foreman. On new installations the instrument engineers train the operators on the instrumentation.

The instrumentation of new construction and unit revisions is assigned to the instrument engineer in the area involved. The individual so assigned works on the project from the beginning. He recommends methods of control and types of equipment, makes estimates on the instrumentation costs and, when the stage of final design is reached, he works directly with the project engineer in the general engineering group on the design and drafting. The same instrument engineer follows the actual installation and stays with the unit during start-up. There are obvious advantages in continuity and the designation of responsibility resulting from the assignment of a single individual to a project in this manner.

Instrument maintenance is handled by the Instrument Department under the departmental foreman. There are four Assistant Foremen, one of whom is in charge of the shop; another specializes in refrigeration and air conditioning. Total personnel is 60. New men start as helpers and enter a training program which permits them to progress in four years to the 1st class classification. During their training period, as soon as they have advanced beyond the helper classification, the new men are assigned to any work that they are capable of doing. Training is almost continuous, formal training courses being scheduled for from two to four hours a week in two-hour periods.

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The instrument department of Shell's Houston refinery participates, as do all operating units of the Shell organization, in that company's Measurement and Control Committee*. The affiliated Shell Development Company is represented on the committee and participates actively, carrying out research on specific problems as need arises. The committee meets annually at the place of the I.S.A. national meeting. Reports are presented on instrumentation projects completed or in progress by the departmental groups throughout the organization. Plant committees, set up in each major refinery, meet frequently and handle local instrumentation problems. Those that cannot be solved locally are referred to the main committee. Plant committees and field organizations serve also to transmit information received through channels set up by the main committee to operating personnel. Membership on all committees is of high calibre, consisting of technical and research personnel, department managers and their technical assistants.

Conclusions

In the organizational arrangements of these representative instrument departments, the principles of good organization have been followed. Related jobs are grouped and manpower assigned that is commensurate with the variety, complexity and proximity of the work. Authority has been delegated sufficient to accomplish the responsibilities assigned. Organization charts have been drawn up which set out clearly who reports to whom and the place of

* J. G. Kerley, "A Centralized Organization of Instrument-application Research," *Instruments*, Vol. 22, Dec. 1949, pages 1098-1099.

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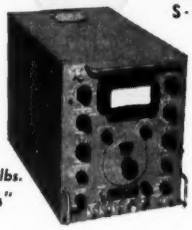

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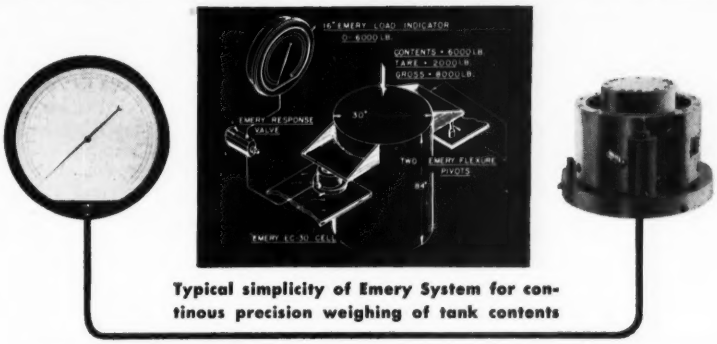

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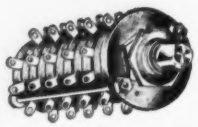
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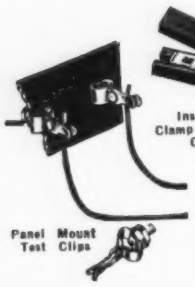
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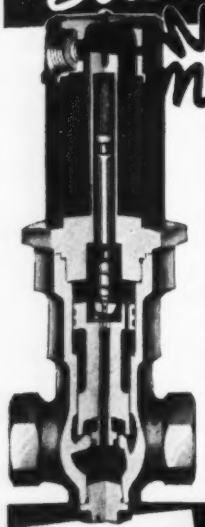

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each individual in the organization. The positions of staff personnel are clearly designated and their status as staff is well defined. Equipment has been provided to permit the personnel to carry out the work assigned.

There are two major problems to which instrument department supervision must continue to give a great deal of attention. I say "continue to give" because it is evident that these problems are already receiving emphasis in the planning of instrument department activities. These are the selection and training of personnel and the increasing complexity both in type and design of instruments for analysis and control.

Ten years ago instrument department personnel were required to install, service, and maintain only standard instruments for the measurement and control of process variables such as pressure, temperature, and flow rates. With relatively short training periods of one to two months it was possible in 1942 for a new man to acquire sufficient knowledge and experience to become a satisfactory instrument maintenance man in most industrial plants.

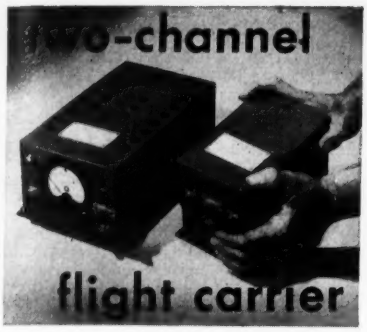
Today the present and potential duties and responsibilities of the instrument technician are markedly different from his duties 10 years ago. The increased complexity of instrumentation work is due primarily to the many improvements and developments that have been made in recording and controlling equipment. It is due secondarily to the appearance of many completely new types of analytical tools which are found in present-day service and research laboratories and which are beginning to appear in plant installations.

Recording process instruments that have been developed during this period include pH recorders, electrical-conductivity recorders, thermal-conductivity recorders, thermomagnetic (oxygen) analyzers, ultraviolet-dispersion analyzers, infrared nondispersion instruments, dielectric-constant meters, leak detectors, and the process monitor mass-spectrometer. New analytical tools that have found many useful applications in both service and research organizations include the ultraviolet, infrared, and mass spectrometers, the emission spectrograph, the polarograph, the Raman spectrometer, the electron microscope, and X-ray diffraction equipment.

As indicated in the discussions of instrument departments, most maintenance work on these modern analytical tools now is performed by members of the laboratory organizations. It may well be that industries have hesitated to install the recently developed instruments in their plants because of the uncertainties associated with servicing and maintenance of this newer equipment. The question of deciding which group—the instrument department personnel or the laboratory research men—should maintain the more complicated spectroscopic tools in the laboratories is one of major interest. On the other hand, there is no question as to who should have the job of installing, servicing, and maintaining continuous recording instruments in the plants. These plant analyzers, regardless of the department or group responsible for the exploratory work that resulted in their recommendation for plant installation, must of necessity become the full responsibility of the instrument field man. Their continued operation in furnishing reliable and valuable information to the process operating group will depend to a great extent on the ability of the instrument man to detect, analyze, and correct faulty operation of any component part of the continuous analyzer system. Further, the instrument man must fully appreciate the need for the analyzer as associated with efficient operation of the plant unit to which it is being applied.

To acquire the above outlined requirements in an instrument department it is necessary for both the department foremen and members of management to recognize the need and work together as a team toward the fulfillment of the need. Specialized and systematic training programs must be provided. Greater care must be exercised in selecting men for particular jobs. Courses in electronics, servomechanisms, elementary spectroscopy and many other fields relating to the chemical, physical and engineering sciences must be made available to the progressive instrument man.

The increasing complexity of the new instruments places



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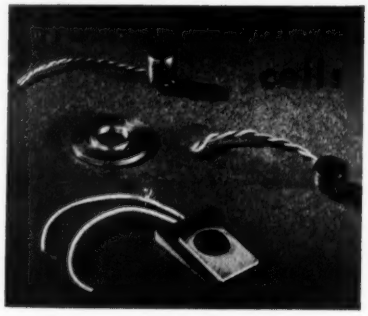

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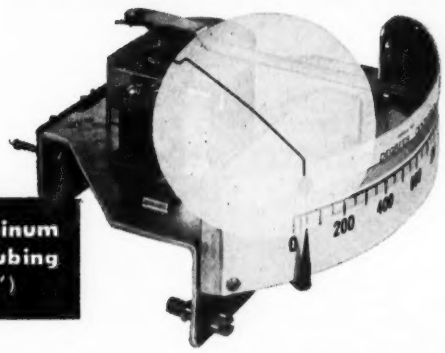

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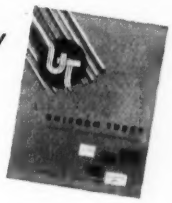

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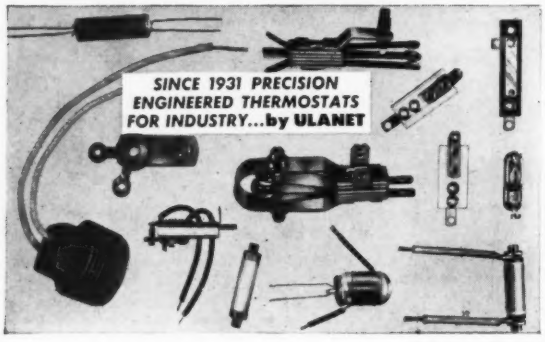

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increased emphasis on the proper selection and training of personnel. If labor organizations insist on contracts which limit the selection of new men or introduce artificial criteria such as seniority into transfer procedures, then instrument departments will find themselves burdened with men who do not have the qualifications for the job of maintaining the more complicated instruments. Costs would rise and efficiency would suffer. The maintenance of electronic instruments, continuous analyzers, and spectrometers would almost inevitably have to remain in the hands of laboratory technicians. If the instrument departments of process industry are to advance and develop, they must be permitted freedom in the selection of personnel that will ensure a work force of qualified men, men with native intelligence and aptitude for instrument work, men with a sufficient elementary educational background to permit their understanding principles of instrumentation.

PRINCIPLES OF FLUID FLOW

Continued from page 1082

valve lift was one inch. Two valve plugs (Fig. 2) were tested—a one-inch size "taper" plug and a 0.5-inch size "groove" plug.

The valve was installed (Fig. 3) with high pressure over the plug and flow out the bottom (Fig. 4). In the tests reported, the valve always was set at one-inch lift (wide

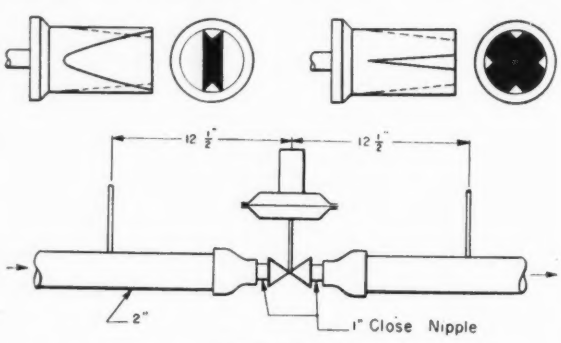

Fig. 2. (Top) Valve plugs.

Fig. 3. (Center) Pipe test installation.

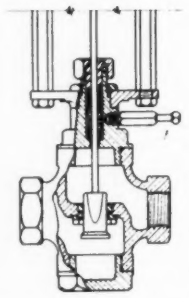

Fig. 4. (Left) Conoflow "Model AB-10" valve body.

open). The pressure differential was varied and the flow rate measured. Six fluids were tested—water and five oils with viscosities varying from 1 to 152 centipoise. Part of the tests were made at Cornell University, Sibley School of Mechanical Engineering. The remainder of the tests were made at Case Institute of Technology, Department of Mechanical Engineering, Process Control Laboratory.

Data for flow coefficient versus Reynolds number are plotted in Fig. 5 for the "taper" plug and in Fig. 6 for the "groove" plug. The data appear reasonably consistent and only three test points out of 85 were discarded for obvious error.

The Reynolds number for a valve is defined as:

$$N_R = 2Q/\nu\sqrt{\pi A^2}$$

and is based on the mean velocity at the port area. There is no theoretical foundation for this selection except that it appears to work in the range of the tests.

There appears to be no question that control-valve coefficients are similar to those for the Venturi tube. In fact,

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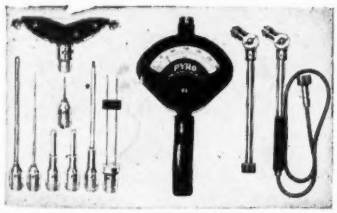

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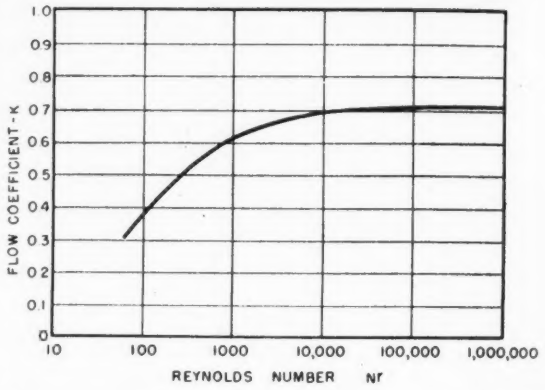


Fig. 5. Flow coefficient vs. Reynolds number for "taper" plug.

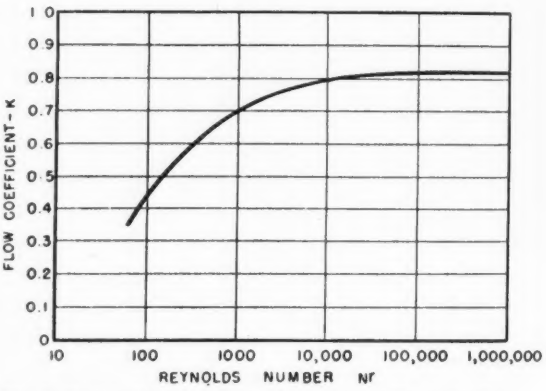


Fig. 6. Flow coefficient vs. Reynolds number for "groove" plug.

the solid lines in Fig. 5 and Fig. 6 correlate the data within about 2.5 percent by the equation:

$$K = K_{max} (C_{VT})^{1.4}$$

and is based directly on the Venturi flow-coefficient (C_{VT}) taken from "ASME Fluid Meters." This is very important because it allows calculation of valve size and flow rate for almost any fluid at any reasonable pressure differential.

The valve flow-coefficient drops off considerably at low Reynolds numbers. Therefore it is concluded that the valve flow-coefficient is smaller when (1) flow rate and pressure differential are small, (2) flow rate is small and port area is large, (3) flow rate and fluid density are small, and (4) fluid viscosity is high. Thus any factor tending to reduce Reynolds number also reduces the flow coefficient.

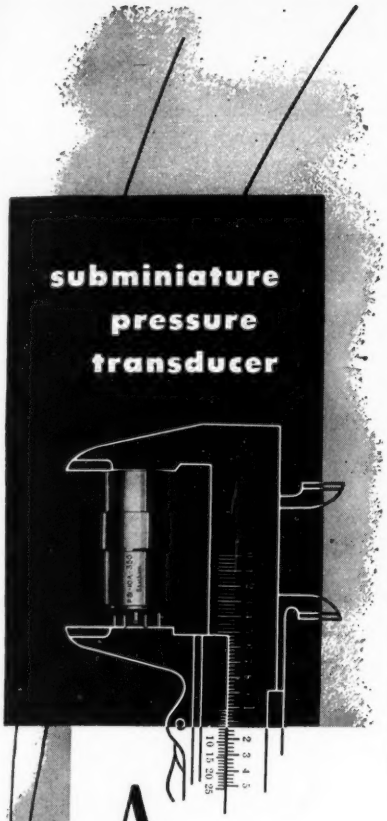
Valve flow-coefficients exhibit a maximum at a Reynolds number of approximately 100,000 because experimental data show the coefficients are smaller at higher Reynolds number. This effect is probably due to increased body losses at high velocities.

Sizing Control Valves

The following procedure should give fairly reliable results for calculation of valve size for given conditions. It is based on the assumption that most control valves have a port area of about 40 percent of nominal entrance area, and that valve-sizing nomographs and slide-rules are based on test data for water flow.

The procedure involves estimating the valve size, determining the maximum flow-coefficient for this valve, calculating the true flow-coefficient, and then calculating the true flow-rate. The general procedure is similar to orifice calculations. The following symbols are used:

ΔP = pressure differential in psi.
Q = flow rate in gpm.
G = specific gravity
C = viscosity in centipoise
D = nominal valve size in inches



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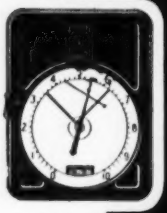

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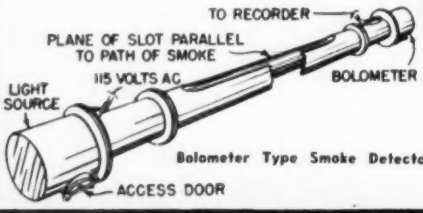
For information on how Bailey can help erase your Smoke troubles write for Bulletin #211 "Bailey Smoke Density Recorder."



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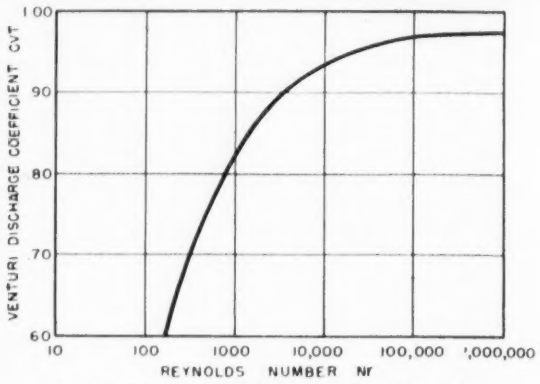


Fig. 7. Venturi flow-coefficient versus Reynolds number.

Outline of Procedure

1. Estimate valve size using nomograph or slide rule. Size valve for water at same flow and pressure differential. Try indicated size (D).
2. Find K_{max} for this valve. (This occurs at N_R=200,000.) Using nomograph or slide rule determine pressure differential (ΔP_W) to produce a flow of $20 \times D$ (gpm.). Then
$$K_{max} = 1.67/D\sqrt{\Delta P_W}$$
3. Calculate Reynolds number for actual fluid from
$$N_R = 5000\,QG/CD$$
4. Determine $(C_{VT})^{1.4}$ from Fig. 7 at N_R of step 3.
5. Compute actual flow-coefficient:
$$K = K_{max}\,(C_{VT})^{1.4}$$
6. Calculate actual fluid flow:
$$Q = 12\ KD^2\ \sqrt{\Delta P/G}$$

Repeat procedure until desired flow is obtained.

Example of Procedure

$\Delta P = 10$ psi., $Q = 20$ gpm., $G = 0.8$, $C = 50$ centipoise

1. Nomograph or slide rule gives approximately 1-inch size for water at 10 psi. and 20 gpm.
2. Nomograph or slide rule gives $\Delta P_W = 5.5$ psi. for $20 \times 1 = 20$ gpm. flow of water.
3. Maximum flow coefficient is
$$K_{max} = 1.67/1 \times \sqrt{5.5} = 0.71$$
4. For actual fluid:
$$N_R = 5000 \times 20 \times 0.8/50 \times 1 = 1600$$
5. From Fig. 7
$$(C_{VT})^{1.4} = 0.85$$
6. Actual flow coefficient is
$$K = 0.71 \times 0.85 = 0.60$$
7. Actual flow is
$$Q = 12 \times 0.60 \times (1)^2 \sqrt{10/0.8} = 25.4 \text{ gpm.}$$

The one-inch-size valve is satisfactory. Note: The 1-inch valve passes 30 gpm. at 10-psi. pressure differential.

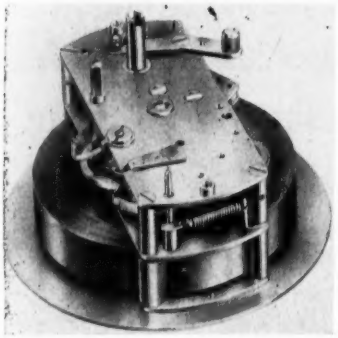
Conclusion

The derivation and experimental tests presented here demonstrate that viscous losses and valve-body losses are two of the most important factors affecting control-valve operation. It has been demonstrated that these losses operate similarly in the Venturi tube and that the operation of the control valve can be calculated for viscous flow once the experimental data are known.

Acknowledgments

The equipment for test was supplied by the Conoflow Corporation. The early test work was completed with the aid of Mr. Charles R. Otto, recently of Cornell University, now Instrumentation Engineer for E. I. duPont deNemours at Wilmington, Delaware. The oils for flow tests were supplied by the Standard Oil Company of Ohio through the courtesy of Mr. W. S. Bowers, Instrumentation Engineer. The advice and suggestions of Professor L. G. Seigel of Case Institute of Technology were helpful in arranging the oil flow tests.

MOVEMENTS



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GAS-PRESSURE REGULATION

Continued from page 1087

Regulator Capacity

The amount of gas that a regulator passes is a function of area of valve opening, pressure differential, and specific gravity and temperature of the fluid. Regulators operating at differences in inlet and outlet pressure below critical velocity have a capacity which can be expressed as

$$Q = K \sqrt{pH}.$$

When operating at pressures at critical velocity or higher,

$$Q = C \times P$$

where Q = quantity of gas in standard cubic feet per hour, H = difference in inlet and outlet pressure in psi., p = pressure at outlet of regulator in psia., P = pressure at inlet to regulator in psia., K = constant for below-critical velocity for a regulator with given size of valve and given temperature and gravity of gas, C = constant for critical velocity for a regulator with a given size of valve and temperature and gravity of gas.

Critical velocity in a regulator is reached when the absolute outlet pressure is approximately 53 percent, or less, of the absolute inlet pressure. At this pressure ratio ($p/P = 0.53$), the gas is traveling at its maximum, or "critical," velocity. It cannot be made to travel faster either by raising the inlet pressure or lowering the outlet pressure. The *quantity* of gas passing through valves cannot be increased by lowering the inlet pressure below the point of critical velocity, but it can be increased by increasing the inlet pressure. Increasing the inlet pressure increases the density of the gas at the valves, thereby increasing the quantity.

Constants C and K usually are given by manufacturers for the maximum capacity of their regulator—that is, with the regulator valves in the position of maximum opening and for a specific temperature and gravity. The constants can be converted to any temperature or gravity by multiplying by the factor $\sqrt{gt/GT}$, where g and t are the gravity and absolute temperature, respectively, of the gas at which the constant is specified by the manufacturer, and G and T are the gravity and absolute temperature of the gas to be regulated.

Capacities of low-pressure regulators frequently are expressed for below-critical velocity as $Q = k \sqrt{H}$. This formula can be used because the term low-pressure regulator usually applies to outlet pressures varying from 0 to 1.0 psig. As p in the basic formula is in pounds per square inch absolute, the variation of one-pound discharge pressure would vary this factor only from approximately 14.6 to 15.6; therefore, the square root of the average of this variable quantity is included in the k of the low-pressure formula.

In sizing a regulator for a given job, it is common practice to select a regulator with capacity more than the maximum which will ever be required of it. Various margins of safety are recommended, but one of the most common is to use a regulator with 50 percent more capacity than the maximum required. As manufacturers often include a margin of safety in their quoted capacities, it is important to determine if their quoted capacities are for maximum capacity or for recommended operating capacity.

In sizing a regulator it is just as important to select a regulator that is not too large as it is to select one that is not too small. Too large a regulator is not only expensive, but also may have a tendency to surge.

Conclusion

In selecting a valve, the single valve is the simplest and gives better shut off. When the capacity required and the pressure differentials are such that the single valve is inadequate, then a balanced valve must be used. In selecting the type of loading, spring loading is the simplest with direct weight loading a close second. Of the methods of pressure loading, simple pilot loading is the simplest. Each of the more complex pilot-loading and instrument-loading methods has its place in pressure control under certain conditions.

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Circuit Restorer

WARREN, Ohio.—The checking of low-resistance circuits (such as thermocouple circuits) for poor contacts and oxidized connections has long been a major source of annoyance to instrument men. Thus the appearance on the American market of a device that not only quickly checks such circuits but also makes automatic repairs for periods long enough to take proper readings is a noteworthy event. The device not only checks circuits but also protects against

production losses incurred because of failure of thermocouples or thermocouple circuits.

The device, called the "Thermocouple Restorer," is connected into the thermocouple circuit. When not actuated, it does not disturb the operation of the circuit in any way; the pyrometer indicates temperature as if no "Restorer" were in the circuit.

However, when the "Restorer" is actuated, it forces a special pulse through the circuit. This pulse jumps across poor, or oxidized connections—even across breaks in the thermocouple. In so doing, it "repairs" the connection and provides a correct temperature reading. Any difference in readings before and after use of the "Restorer" indicates a previously existing fault in the circuit. Further, as the "repair" lasts for an interval after each use of the pulse, a calamitous failure is impossible.

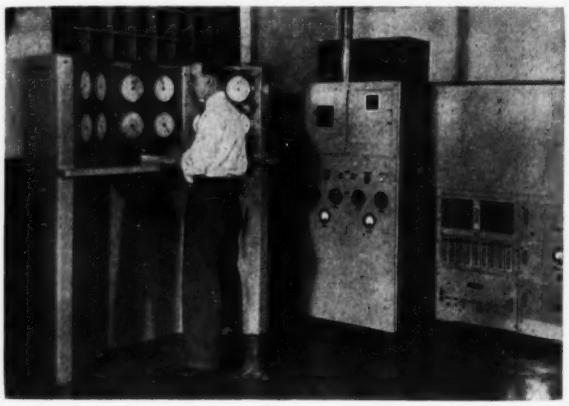
The "Restorer' is made by Sherman Electric Company, Warren, Ohio, in either portable or panel type. One "Restorer" can be used for as many thermocouple circuits as desirable; picture shows arrangement for 12 circuits.

New Instrumentation Magazine

ENGLAND.—A new journal entitled *Instrument Engineer*, is being published by George Kent, Ltd., Luton, Bedfordshire, England. Intended for the use of the instrument engineer, the journal will be published twice yearly. Rates are 2s. 6d. per copy; 5s. per year.

Direct-reading Spectrometer

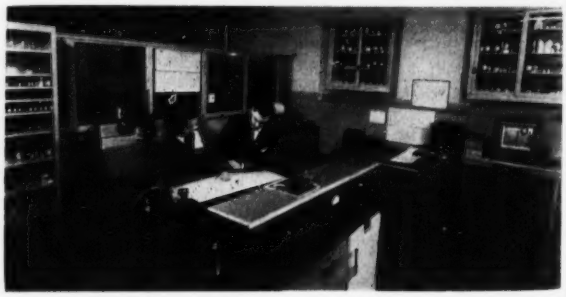
TORRINGTON, Conn.—The American Brass Co., Torrington, Conn., is using a Direct-reading Spectrometer of Baird Associates in production control of copper-base al-



loys. The dial indicators directly indicate the concentration of various metals in the alloy as measured from the distribution of spectral lines in the spectrometer. A complete sample-analysis-report cycle requires 6 to 8 minutes. The previous method required the sending of samples to a laboratory. The picture shows the instrument and Spectrographer R. I. Ray reading the indicators.

Infrared-Spectrometer Application Service

NORWALK, Conn.—New Perkin-Elmer instrument laboratory at Norwalk, Conn., has complete facilities and personnel for evaluating applications of infrared spectrometry



to specific analytical or control problems of companies and research institutions. There is no charge for the service. Equipment for evaluating flame photometry and the Tiselius Electrophoresis Apparatus also are available.

Priority M-71 Amended

WASHINGTON, D. C.—To enable scientific and technical laboratories to expedite their defense work the National Production Authority, Commerce Department, made

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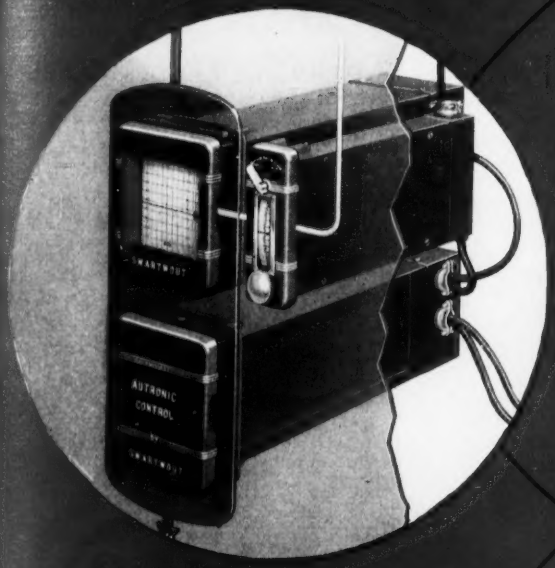
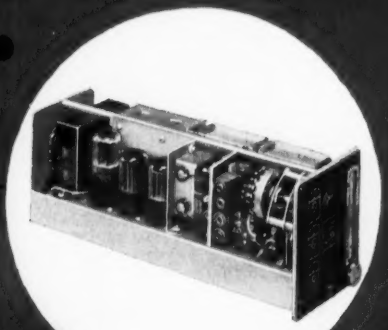
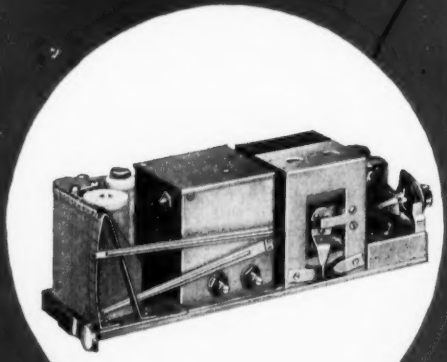


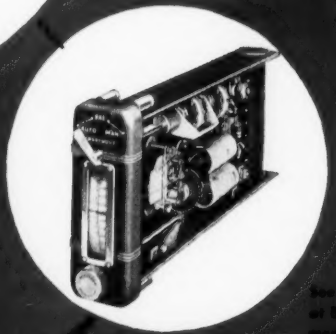
1 Completely revolutionary, the Autronic Control System is the *first miniature all-electronic centralized control system.* Signal transmission throughout system is by electrical means only—right from primary element to final element. This means that control is positive and accurate because there are no transmission lags . . . no boosters, slide wires, motors . . . no air lines to leak, corrode or freeze up. Autronic Controller can be located at any point. Cable length unimportant with highest accuracy maintained over distances of over 1000 feet.





2 AUTRONIC CONTROLLER *(case removed)*—Infinite sensitivity is provided by completely eliminating all mechanically moving parts. Proportion, reset, and rate-action adjustments; direct or reverse acting. Model shown has set-point. When used with Autronic Recorder, set-point is on recorder.

3 AUTRONIC RECORDER *(case removed)*—Has no slide wires or contacting mechanisms. Pen writes on curved edge of chart with same radius as pen arm to give *true linear trace.* Double-sprocket drive. Holds 1-month paper supply. Three-position response-speed adjustment.



4 MANUAL CONTROL *(case removed)*—Edge-reading dial calibrated from 0 to 100 continuously indicates control output. With changeover switch in balance position, dial reads difference between controller and manual outputs. Fast "bumpless" changeovers made by adjusting manual or automatic output to center-index line.

See the Autronic Control System on display at Booths 222 and 224, 7th National Instruments Exhibit, Cleveland, September 8-12th

Swartwout *Autronic* CONTROL SYSTEMS

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three major changes in its laboratory priorities order, M-71. The most important change permits laboratories having defense contracts to extend ratings bearing military or Atomic Energy symbols for material and parts needed to fulfill these contracts. NPA now authorizes defense contract laboratories to attach the suffix "B-5" to the laboratory preference rating X-1 for both controlled steel, copper, and aluminum and uncontrolled materials and components needed for military and AEC projects. Thus the materials and components needed for laboratory work on defense orders will receive the same procurement preference as the orders themselves.

The two other major changes are (1) removal of self-certification dollar limit for procurement of uncontrolled materials and supplies, and (2) raising most controlled-materials quarterly self-certification limits.

Radioactivity Survey Instrument

WASHINGTON, D. C.—A new gamma survey instrument recently has been developed by S. R. Gilford and S. Saito of the NBS. The instrument requires no microammeter because radiation levels are read directly from

a potentiometer dial. The operator turns the dial to the point at which an audio oscillation begins, as determined aurally by earphone. The device uses (1) a detector tube of the halogen-filled GM type, (2) a vibrator high-voltage power supply operating from flashlight-type batteries, and (3) a thyratron relaxation-oscillator circuit. If the potential difference between the grid and cathode of the thyratron exceeds the firing potential, the circuit oscillates.

Nucleonics Measures Fabric Coatings

DENVER, Colo.—Gates Rubber Company, Denver, Colorado, is using a new control system on tire-and-belt-making lines. Utilizing nuclear equipment developed by Industrial Nucleonics Corporation, Columbus, Ohio, the new device detects variations in the weight of the rubber coating given cord and fabric before these variations have a chance to affect quality. The installation marks the first successful effort so far to control the uniformity of the rubber-coated cord or fabric going into tires, V-belts and other products made at the Gates plant.

Analog Computer

AKRON, Ohio.—A new electronic device, the "Model L3 GEDA" (linear Goodyear electronic differential analyzer), will be released at the 7th National Instrument Exhibit at Cleveland by the Goodyear Aircraft Corporation, Akron, Ohio. The analog-computing equipment, for experi-

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AND CONTROLS

Do You Know About ALL of the **REPUBLIC** *Line?*

Check the Republic line of measurement and control equipment listed below. You'll find instruments and controls to meet your needs—whether for a simple control or an automatic control system. And teamed with this equipment is an experienced engineering staff which can give you the right answer to your measurement and control problems.

☐ **ELECTRICAL FLOW METERS.** For metering the flow of steam, water, gas, air, oil, brine, etc. The reading instruments, indicator, recorder and integrator, are remote reading and can be supplied singly or in any combination desired. Integration is continuous, an exclusive Republic feature.

☐ **PNEUMATIC TRANSMITTERS.** For converting process variables such as flow, liquid level, pressure, or liquid density into air pressures which vary proportionally with the process variables. These air pressures can be used as a measuring impulse for the actuation of an automatic controller or a direct reading recorder.

☐ **CO_2 METERS.** Provide a continuous record of percent CO_2 in flue gas measured by the Orsat method. Furnished with either mechanical or electrically actuated remote reading indicator and recorder.

☐ **DRAFT INSTRUMENTS.** Indicating or recording types in single or multiple units. Furnished in all standard ranges of draft and pressure.

☐ **THERMOMETERS.** A long distance, gas filled thermometer with either single or multiple pen recorder.

☐ **LIQUID LEVEL INSTRUMENTS.** Remote reading indicators and recorders. Also provided with various types of alarm devices.

☐ **MULTI-POINT INDICATORS.** Will indicate, on separate vertical scales from two to sixteen units of draft, pressure, flow, temperature, CO_2, etc., in any combination desired.

☐ **MULTIPLE RECORDERS.** Strip Chart Type will record from three to six separate records of flow, temperature, CO_2, pressure, etc., in any combination desired. Round Chart Type can have up to 4 pens.

☐ **REGULATORS.** For the automatic control of pressure, draft, rate of flow, rate of fuel feed, speed of rotation, liquid level, etc. For proportioning two pressures or flows. Regulators may be either air or oil operated. Flexibility in design and construction allows the regulator to perform any type of control action. Setting may be remote or manual.

☐ **AUXILIARY RELAYS.** Multiplying, dividing, adding, subtracting, maximum and minimum setting, ratio, ratio computing, sequential, splitter, squaring, square root extracting, and position indicating.

☐ **COMBUSTION CONTROLS.** A centralized, automatic system for controlling steam pressure, combustion, furnace pressure, excess pressure, boiler level, etc. Automatically regulates the fuel and air input to a boiler in measured proportions and in a fixed ratio for the entire load range. Adaptable to multi-fuel firing.

☐ **DESUPERHEATERS.** Atomizing type desuperheater uses a small quantity of high pressure steam to vaporize an automatically controlled amount of water in reducing steam temperature to the desired degree.

☐ **VALVES—REGULATING AND PRESSURE REDUCING.** Designed and built for all practicable ranges of pressures with either flanged or welded ends. Special body design sharply reduces erosion and noise. Cylinder operated valves available in sizes from 3 in. to 24 in. Hand operated valves in sizes from 1 in. to 8 in. Lever operated valves in sizes up to 16 in. Republic valves are built in accordance with A.S.A. Standards for all pressures up to 2500 psi. Diaphragm operated valves are available for pressures from 125 to 1500 psi and from 3 in. to 10 in. in size. Special purpose alloy steel butterfly valves in sizes 4 in. to 24 in. are also available.

Data Books are available on any of the above equipment

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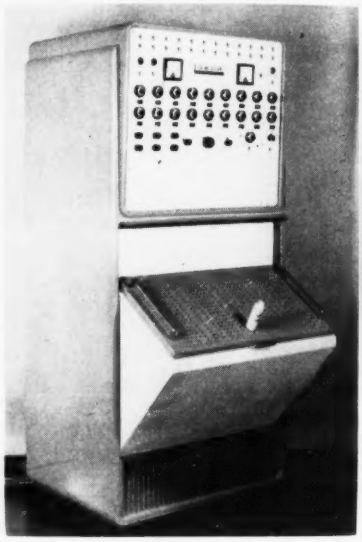
mental analysis of dynamic systems, permits the solution of differential equations up to the 12th order; a number of analyzers may easily be connected for the solution of more complicated problems, which may be programmed from any analyzer, an output recorder, or a



custom console. Boundary-value problems and devices having static or coloumb friction, backlash, velocity or acceleration limiting, etc., may be studied. Ten initial conditions are set simultaneously on each "GEDA" by the single program switch. Features include removable problem board and plug-in units.

University of Tokio Instrumentation Department

The following letter from Professor Takashi Isobe of Japan outlines the first university-level Department of Instrumentation in the world. This will be of particular interest to American Universities contemplating expansion of courses in instrumentation.

I take the liberty of introducing to you the Department of Technical Measurements, Faculty of Engineering, University of Tokyo, which is specialized in instrumentation.

This new department was established in 1945, being planned to work along the following lines: To find the best measuring methods for industrial and scientific measuring problems by analyzing and synthesizing all possible electrical, mechanical or chemical measuring principles and techniques; to initiate measuring instruments and procedures by applying new physical principles; to train students who will be instrument engineers or designers.

Of course, in many technological institutes and colleges, there are being made

researches and lectures on instrumentation. But they are dispersed in various engineering departments and they are only on the problems in the respective special fields. In order to find the best principle, it is necessary to search it in the widest fields. These were the

ISOBE BEHAR PIGOTT

When Professor Isobe spent two days in Pittsburgh, the Editor of *Instruments* took him to several plants and labs. At Gulf Research Laboratories, Chief Engineer R. J. S. Pigott gave nearly one full day of his time to his two visitors.

thoughts of the originators of this department.

The department has six main sections and their respective working fields are as follows:

1. Fundamental principles of measurement and control.
Basic measurement of length, mass, time, speed, flow, pressure, force, viscosity, etc.
Industrial instrumentation.

2. Electric and magnetic measurements.
Electric circuit analysis, electric and magnetic measuring instruments, electron tube applications.

3. Thermal measurements and mechanical measurements.
Temperature measurement, calorimetry, thermodynamics.
Gages, clocks, balances, surface testers, testing machines, etc.

4. Optical and acoustical measurements.
Optical measuring instruments, spectroscopy, photometry, and colorimetry.
Acoustical measuring instruments, supersonics.

5. Mathematics to be applied to instrumentation.
Mathematical analysis, numerical calculations.
Quality control, applied statistics.

6. Materials for instrument design.
Physical and mechanical properties of metallic and non-metallic materials for instruments, such as beryllium copper, phosphor bronze, elinvar, and neoprene.

Students in this department have to go through three school years until they will be given the degree of bachelor of engineering. One class has about thirty students, and the department has totally about ninety students. (The University of Tokyo has about ten thousand students in seven faculties, and the Faculty of Engineering has twelve hundred students in twelve departments.)

In the first school year, the students receive training principally in physics, mathematical analysis, mechanical drawings and some elementary courses of instrumentation. In the second year, they receive general courses of instrumentation of all kinds. In the third year, they may select one narrow field to be specialized, and each of them has a

Stable as a *Wirewound* Resistor*

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DC VOLTS
DC MILLIVOLTS
AC VOLTS
AC MILLIVOLTS
OHMS
MEGOHMS
STANDARD CELL
DC AMPLIFIER

THE MODEL "R" VOLTMETER

The Model "R" is primarily intended for the precise measurement of DC potentials, providing DC voltage ranges from one volt full scale to 1,000 volts full scale; however, to allow the instrument its greatest possible utility, the following auxiliary functions have been included in its design:

Distended DC Voltage Ranges: **Bucks out 99% of measured voltage and indicates 1% of measured voltage full scale.**

DC Millivolt Ranges: **One millivolt full scale to 1,000 millivolts full scale.**

AC Volt and Millivolt Ranges: **One Millivolt full scale to 1,000 volts full scale.**

Self-Contained Standard Cell: **For instant check of voltmeter calibration.**

Ohms Ranges: **Times one to times 10^6.**

Distended Ohms Ranges: **Reads bottom half of ohms scale full scale.**

DC Amplifier: **Will drive a one ma recorder, has gain of 200, and frequency range of zero to 100 kc.**

*This statement refers to the fact that precision wire-wound resistors are used for all attenuators and range resistances, and that the DC Amplifier is a highly degenerative system employing wirewound resistors for the beta network. It has been found that changes in gain with warm-up are in the order of .1 of 1% and are primarily due to the temperature coefficient of the resistors in the beta network.

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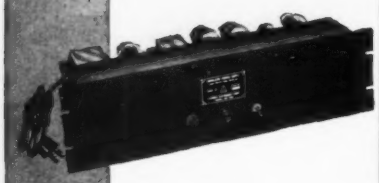

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MODEL 28 STANDARD RACK MOUNTING

PANEL SIZE 5¼" x 19" WEIGHT 16 LBS.

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin N8

LAMBDA ELECTRONICS CORPORATION
CORONA NEW YORK

particular subject of work to write as a thesis for graduation.

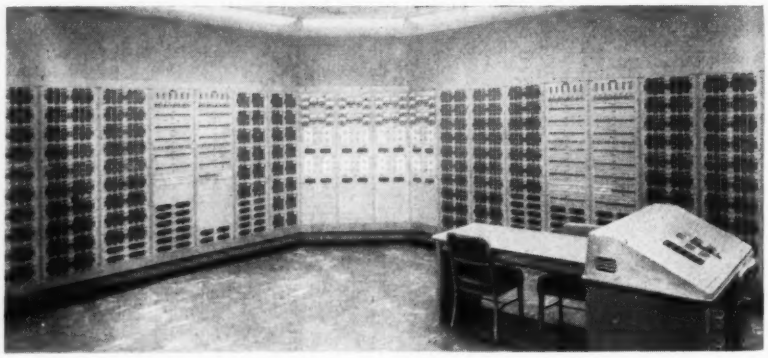
Until now the department has sent out 120 graduates. All of them have had jobs, and their principal types are as follows:

1. In industrial plants, such as steel, textile, paper making, oil refining, and chemical plants, as instrument engineers.
2. In instrument-makers' plants, as instrument designers.
3. In governmental research laboratories, as research workers.

[Plans are now under way to change the school system from 3-year to 4-year courses, and to unite the Department of Technical Measurements with the Department of Applied Physics, making the former a Division in the latter, but with staff and working fields unchanged.—ED]

Network Analyzer

URBANA, Ill.—The Department of Electrical Engineering of University of Illinois dedicated a new 10,000-cycle network analyzer on April 30, 1952. The analyzer consists of 20 generator units, 152 pi line units, 56 load units, 34 auto-transformers, 28 capacitor units and 24 mutual transformers. Two metering desks make it possible to study two separate problems simultaneously.



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Eliminates Snubbers—
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ACRAGAGE CO.
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Instrument Lighting

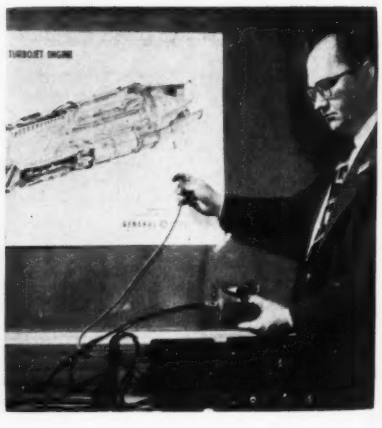
CLEVELAND, OHIO.—"Ring" lighting has been adopted as standard for aircraft instruments by the U. S. Air Force and the Navy's Bureau of Aeronautics. The new system calls for a lighting fixture around each instrument, rather than a general lighting arrangement for an entire panel of instruments.

General Electric has adapted miniature bulb No. 327 for the "ring" fixtures. Two bulbs are inserted in red plastic holders at the top of each instrument. The filters produce a red light, found to be best for dark adaptation of eyes.

Light Probe

SCHENECTADY, N. Y.—"Seeing" light in hard-to-study sections of jet engines has been solved by a new flame detector, which although bent and twisted, can reach formerly inaccessible places.

Developed by the General Electric



Engineering Laboratory, Schenectady, the instrument combines a fused quartz-and-steel probe with a phototube to record flame characteristics of burning gases in aircraft jet engines. The 4-foot quartz filament transmits detected through its length to a photoelectric converter and amplifier. Fused quartz can transmit a wide range of light waves, has a high melting point, and

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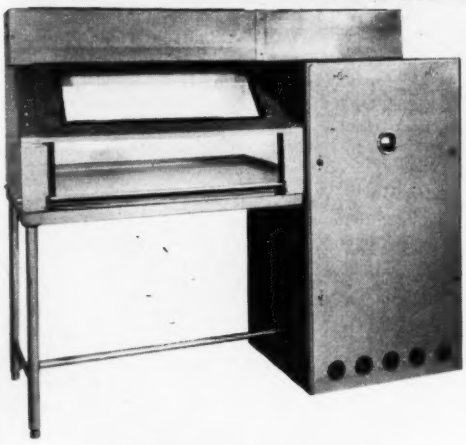

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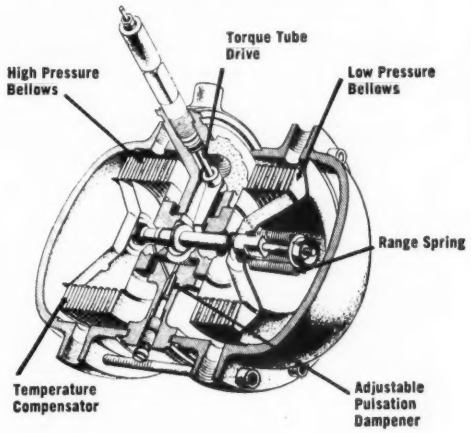

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NO LIQUID SEALS TO LOSE–corrosive and volatile liquids are handled without seal pots, thus reducing installation and upkeep costs.

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Highest quality standards

FEATURES

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2. 40 in. oz. synchronous torque at 1 RPM.
3. Voltages up to 550 (without resistors or accessories.)
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8. Available in reversible type motor.

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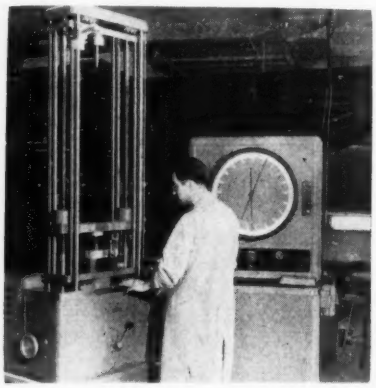
can survive twisting and bending. C. R. Droms, engineer, points the flame detector at a jet tailcone, one place where G-E engineers now can study flaming gases.

Load-deflection Tests

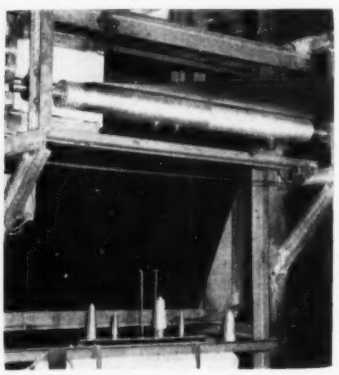
ERIE, Penna.—The Lord Manufacturing Company, Erie, Penna. manufacturer of vibration-control mountings uses a "Model PTE Baldwin" universal testing machine of 5000-lb. capacity and



an autographic recorder for obtaining rapid and accurate load-deflection characteristics. Deflections of mountings are measured by movement of the core of a miniature variable transformer ("Microformer") mounted on the platen of the testing machine. A similar "Microformer" in the recorder rotates the chart roll proportionally and plots automatic load-deflection curves.

Beta-ray Gage

DES MOINES, Iowa.—The Armstrong Rubber Mfg. Co., Des Moines, uses a General Electric beta-ray thickness gage (upper left) to continuously



and automatically monitor fast-moving strip of rubberized cord as it races through the calendar rolls at the rate of thousands of yards a day. Beta rays are emitted from a tiny source of Strontium 90, a by-product of the atomic furnaces at Oak Ridge, Tenn.

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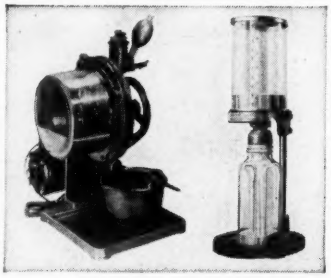

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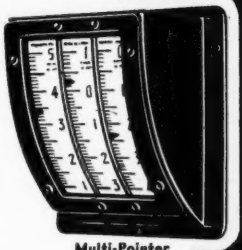
You will find the Bailey Multi-Pointer Gage a valuable asset in achieving safe, consistent and economical furnace operation. Its design, which places from two to twelve indicating units side by side, permits the establishment of a pointer pattern (overall picture of related factors shown graphically) easily recognized by operators. Any deviation from the established pattern is quickly noticed; appropriate adjustments can be made to re-establish the desired conditions.



Multi-Pointer Bailey Gage

Low pressures, drafts, and differentials are accurately measured by this diaphragm-operated gage. Long life and sensitivity of diaphragm units are obtained by the use of a Bailey developed Diaphragm Material, which is resistant to oil, acid, caustic, and heat.

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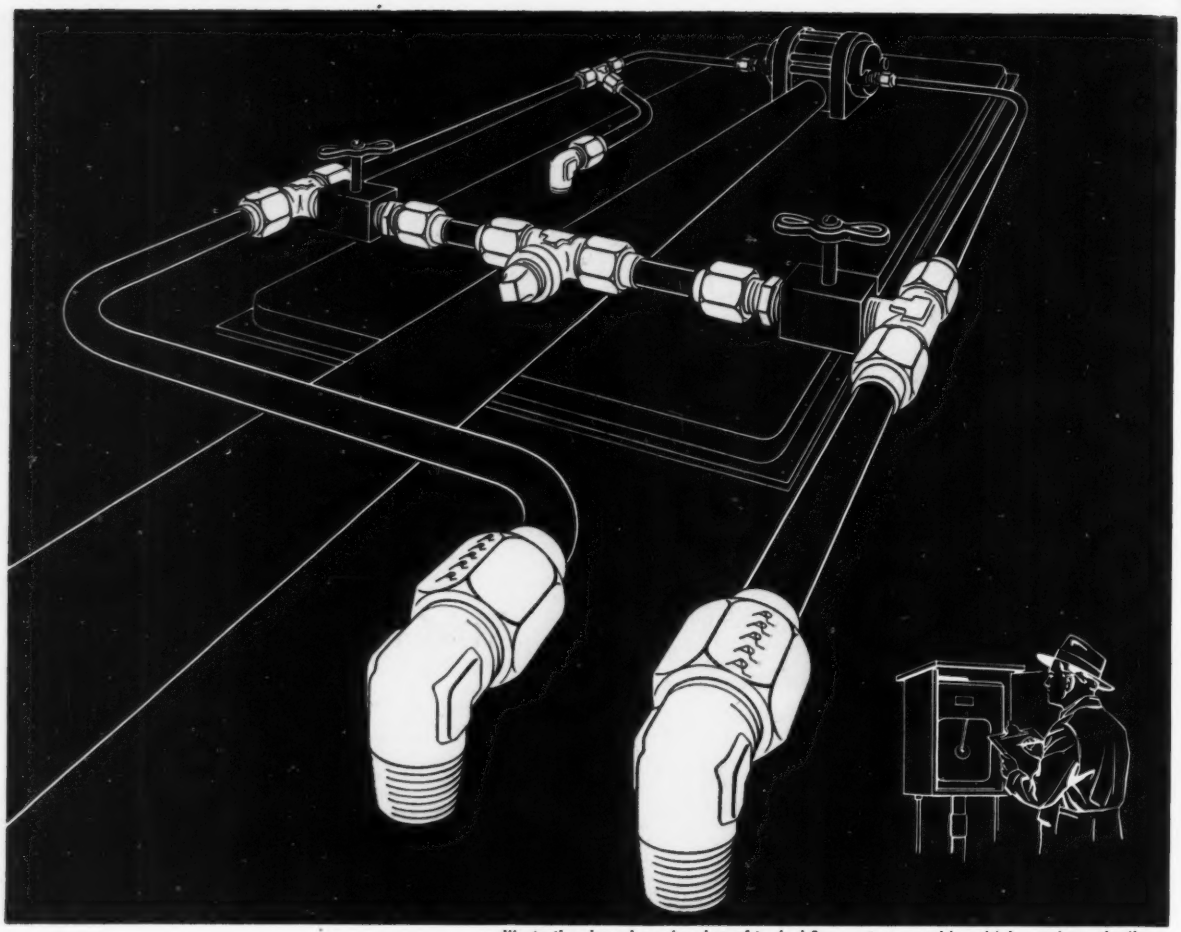

Illustration based on drawing of typical flow-meter assembly, widely used on pipelines.

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PRESSURE RECORDERS

Continued from page 1090

stuffing box is packed. An approved method includes the insertion of a thin graphited permanite washer over the end of the shaft protruding from the box. This is followed by a graphite- and oil-impregnated felt washer and a second permanite washer, the three being forced into the stuffing box with a thrust from a piece of rubber tubing over the shaft. The packing follower is then replaced. It has been found that fitting an 8-inch crescent wrench on the follower and rotating the shaft while setting up the weight of the wrench provides sufficient pressure to seal the stuffing box against a service pressure of one hundred pounds. This procedure eliminates all friction and yet allows for adjustment during future inspections. Recently developed stuffing boxes use a waxy plastic known as "Teflon" for bearing surfaces. This material flexes under pressure to secure a tight shaft fitting without the usual forms of lubrication.

When the gage parts have been reassembled, the adjustment block is locked to the flat portion of the shaft by a set screw and the pen arm is mounted on the shaft. The pen is made to record a sub-zero reading of about ⅜ inch. At this time the meter body is checked with a level placed across the machined top surfaces of the chambers. With both chambers open, clean mercury is poured into the chambers until the differential pen rests on zero. The high-pressure-side cover is replaced and the water manometer connected. The instrument is then calibrated.

Level and Mounting

Frequently a recorder is jarred from its original level position by vibration or the settling of the ground. Where a recorder is mounted on a pipe line exposed to extreme temperature changes, the expansion and contraction of the pipe line can throw the gage out of level.

When the gage is out of level it changes the mercury level area in the chambers and they no longer have their original ratio. Thus an error in measurement is introduced.

A satisfactory mounting for the instrument is found in the use of a 3-inch-pipe standard, set in a block of concrete about eighteen inches square and eighteen inches below ground level with 36 inches of pipe above the ground. This is reduced to 2-inch pipe and a ground-joint loose-ring flange union is installed for levelling the gage. A 2 x 18 inch nipple from this union supports the recorder. This standard brings the chart hub about 54 inches above the ground, eliminates vibration from pipe lines, and allows repairs to line or meter run without disturbing the gage.

A bent pen arm or one of incorrect length can cause an error. The length of the pen arm should be adjusted so that the pen follows the time arc of the chart.

Static Pressure Unit

The second portion of a recorder of this type is the static-pressure tube and the recording connections. The static pressure is measured by an ordinary Bourdon tube with linkage to the recording pen.

Calibration is accomplished by comparison of recorded pressure with that shown on a manometer or a test pressure-gage. Corresponding readings are obtained by adjustment of linkage arms. General practice requires an exact comparison with the manometer or test gage at the expected working pressure range of the instrument. Maintenance includes frequent cleaning to prevent corrosion, inspection for friction or lost motion, and a check with the manometer or test gage. The pen arm length should place the static pen near the differential pen without any interference between the two.

A few common troubles found in recording pressure include (1) the pen rides the chart too heavily; the pen should rest just heavily enough on the chart so that if the chart plate is pressed in ⅛ of an inch the pen will hang free; (2) condensate collects in the lines to the recorder; the record of the pressure will be increased one pound for every 27.79 inches of water head. If oil or other liquid is present the error will vary with the weight of the head of liquid in the gage piping. If liquid seals are used the pressure pen should be compensated for the liquid head used; (3) incorrect zero-pressure settings where square-root charts are used. The zero setting is different for each range of static element. The following formula can be used to determine the correct zero setting for the static pen:

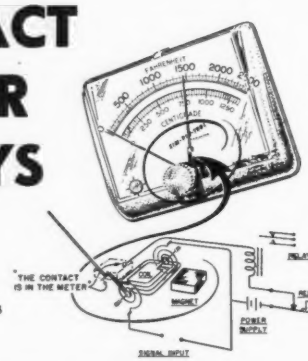
$$\sqrt{\textit{Barometer in lbs.}/(\textit{Range of spring}/100)}$$

Tools and Equipment

Tools and equipment needed to service the combination differential and static recording gage include:

(1) Manometer, graduated in inches of water.
(2) Pressure test gage, graduated in lbs. per sq. inch.
(3) Clean mercury, 6½ to 8½ lbs.
(4) Emery cloth, fine.
(5) Carbon tetrachloride or white gasoline, 1 pt.
(6) Clean rag, lint free.
(7) Screwdriver, 3 inch.
(8) Wrenches: 12-, 8-, and 6-inch Crescents.
(9) Alcohol, small vial to clean pens.
(10) Hone, small, to hone pens.
(11) Pipe cleaners, to clean pens.
(12) Grinding compound, very fine.
(13) Shoe string, 18 inches in length.
(14) Pipe wrenches: 8, 10, 14, 18, and 24 inches.
(15) Key, clock.
(16) Recording ink, 1 oz. red and 1 oz. blue.
(17) Charts.
(18) Replacement parts.
(19) Hose, for connecting manometer.

CONTACT METER RELAYS



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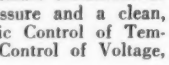

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ground through V1, which prepares the circuit for the next pulse.

A *step-by-step* counting circuit is shown in Fig. 11-16. Note that it is like the counting circuit in Fig. 11-15 except that capacitor C_2 is used instead of a resistor. Capacitor C_2 is made much larger than capacitor C_1 so that each time diode V2 conducts, capacitor C_2 charges a little, whereas C_1 is charged a lot. At the end of each incoming pulse, the negative charge on C_1 is discharged by diode V1, which prepares the circuit for the next pulse.

For accurate step-by-step counting, capacitor C_2 must be larger than C_1 and each incoming pulse must be alike in amplitude and duration. Note that in both counting circuits the pulses must be alike in both amplitude and shape.

The step-by-step counting circuit often is used as a *frequency divider* by using it to trigger a gas tube or blocking oscillator at some definite voltage that is reached after a certain number of input pulses. This produces one output at the end of a given number of inputs, thus producing frequency division.

Phase Shifters

It often is desired to change the phase of a wave. The simplest way to do this is to use a simple *R-C* or *R-L* network, as in Fig. 11-17. As the resistor and capacitor (or inductor) are in series, the current is the same in each. Therefore, the voltage drop across the resistor is 90 degrees out of phase with that across the reactance. (Note that this is a method for obtaining two voltages exactly 90 degrees out of phase with each other—that is, for *phase splitting.*) By varying the resistance, the voltage across either the resistance or the reactance changes in phase with respect to the input voltage.

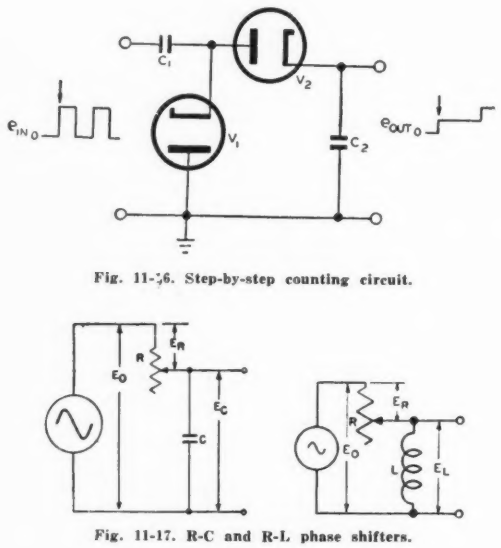

Fig. 11-16. Step-by-step counting circuit.

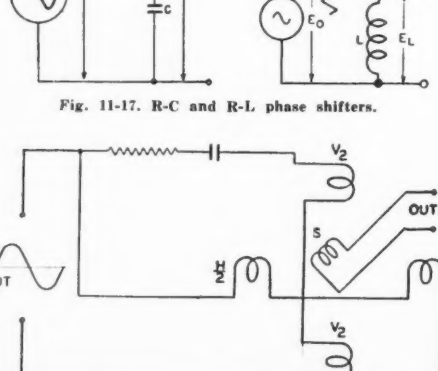

Fig. 11-17. R-C and R-L phase shifters.

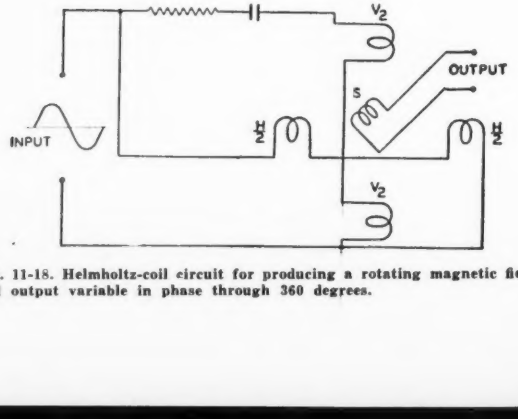

Fig. 11-18. Helmholtz-coil circuit for producing a rotating magnetic field and output variable in phase through 360 degrees.

The *R-C* or *R-L* phase shifter can produce only moderate phase shifts of considerably less than 90 degrees. For obtaining a continuously variable phase shift over 360 degrees, it is customary to use a rotating magnetic field.

Rotating Magnetic Field

A rotating magnetic field can be produced by two sets of coils at right angles to each other in a Helmholtz-coil circuit (Fig. 11-18). The horizontal set of coils is energized directly by the input sine wave. The vertical set is energized by the same sine wave but only after a 90 degree shift in phase by the *R-C* phase shifter. When the two sets of coils are energized simultaneously, the vector sum of the two fields is a vector that rotates continuously through 360 degrees.

A pick-up coil placed in the resultant field has induced in it a sine wave of the same frequency as the input because of the rotation of the field. However, the phase of the output with respect to the input can be varied continuously through 360 degrees by a 360-degree orientation of the pick-up coil in the rotating field of the Helmholtz coil.

Phase changing of sine waves does not alter the shape of the wave. However, phase shifting of nonsinoidal signals by the methods described does alter the shape of the signal. It often is desired to delay (change the phase of) pulses. For this purpose it is necessary to use *delay lines*, which are devices that cause pulses or signals to travel at reduced speeds. For example, a signal travels through mercury slower than through a wire. Thus a mercury delay line can be used to delay a pulse by a desired amount. Other delay lines are made of distributed-constant transmission lines. Delay lines are used to delay pulses for intervals of microseconds, as in the radar and microwave instrumentation.

TEST ITEMS FOR XI (Part 2)

11-13. A series-diode limiter differs from a parallel-diode limiter in that the former
- (a) is simpler
- (b) limits when nonconducting
- (c) clips positive extremities of waveforms
- (d) clips negative extremities of waveforms

11-14. An overdriven amplifier used to convert a sine wave into a square wave should use
- (a) both saturation and cut-off limiting
- (b) a low B-voltage
- (c) a large signal
- (d) all the above

11-15. A clamping circuit is used to
- (a) change the reference level of a signal
- (b) limit either extremity of a signal
- (c) convert sine waves into square waves
- (d) all the above

11-16. A peaking circuit is used to produce
- (a) sharp pulses
- (b) sine waves
- (c) sawtooth waves
- (d) phase shifting

11-17. The most common peaking circuit is the
- (a) overdriven amplifier
- (b) saturable reactor
- (c) R-C differentiator
- (d) cyclophon

11-18. A gate voltage is a pulse that
- (a) has a sawtooth waveform
- (b) has a sharp peak
- (c) turns circuits on and off
- (d) is produced by a saturable reactor

11-19. The term "electronic switch" applied to a switching circuit usually refers to a
- (a) diode limiter
- (b) multivibrator
- (c) saturable reactor
- (d) counting circuit

11-20. A step-by-step counting circuit differs from a frequency-type counting circuit in that the former
- (a) charges a capacitor in intervals
- (b) measures average current through a resistor
- (c) uses two diodes
- (d) is insensitive to pulse shape

11-21. Phase splitting refers to obtaining two voltages that are
- (a) in phase
- (b) 90 degrees out of phase
- (c) 180 degrees out of phase
- (d) changed in phase by a factor of two

11-22. The simple *R-C* or *R-L* phase shifter can produce phase shifts of
- (a) less than 90 degrees
- (b) more than 90 and less than 180 degrees
- (c) up to 180 degrees
- (d) up to 360 degrees

11-23. A Helmholtz-coil circuit contains
- (a) two coils energized 180 degrees out of phase with each other
- (b) two coils energized in phase
- (c) two pairs of coils energized 90 degrees out of phase with each other
- (d) four coils energized in phase

11-24. The output signal of a Helmholtz-coil phase shifter can be charged in phase through 360 degrees by
- (a) rotating the phase of the crossed coils
- (b) energizing one of the four coils in the circuit
- (c) rotating the pick-up coil through 360 degrees
- (d) all the above

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Temperature

U-724 **Pyrometers.** 4-page Bulletin G-3 illustrates and describes maker's line of portable, bench, and panel "Sim-Ply-Trol" indicating pyrometers. 4-page Bulletin G-1 covers contact-type meter-relay controllers. 4-page Bulletin G-2 covers indicating and controlling pyrometers.—Assembly Products, Inc., Chagrin Falls 3, Ohio.

U-725 **Time-proportioning Temperature Controller.** 8-page Bulletin 1052 illustrates and describes maker's "Pulse Pyr-O-Vane" indicating millivoltmeter controller which provides time-proportioning furnace-temperature control action. Includes principle, specifications, application data, and ordering information.—Minneapolis-Honeywell Regulator Co., Sta. 40, Brown Instruments Div., Wayne & Windrim Aves., Phila. 44, Penna.

U-726 **Electric Control Thermometers.** 10-page illustrated Catalog 6482 describes recording and indicating circular-case electric-control (mercury-switch-activated) industrial temperature controllers for ovens, kettles, tanks, etc. Includes principle of switching action, ranges, and specifications of bulbs and tubing.—Minneapolis-Honeywell Regulator Co., Sta. 40, Brown Instruments Div., Wayne & Windrim Aves., Phila. 44, Penna.

U-727 **Furnace Instrumentation.** 4-page Vol. 11 No. 3 issue of "Wheelco Comments" features articles on controlling and protecting gas-fired annealing furnaces and boilers.—Barber Colman Co., Wheelco Instruments Div., Rockford, Ill.

U-728 **Resistance Thermometers.** 6-page brochure illustrates and describes new "Type 21" bulb temperature pick-ups for ranges from 32 to 1832 deg. F. Includes response, characteristics, specifications, application notes, and prices.—Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.

U-729 **Precision Potentiometers.** 4-page Specification Sheet 177 illustrates and describes new console-type operator's desk and "Electronik" precision indicating potentiometer. Includes features, specifications, and applications as pyrometer or millivoltmeter.—Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 40, Wayne & Windrim Aves., Phila. 44, Penna.

U-730 **Calender-temperature Control.** 8-page Vol. 12 No. 1 issue of "Modern Precision" features articles on industrial-instrument applications, including control of tire-cord fabric-calender temperature, load-frequency control of electric power plant, temperature control of blast furnace, and others.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Penna.

U-731 **Heating-control System.** 4-page illustrated Bulletin R-1 covers maker's "Proportionator" controller for vapor-heating systems. Includes principles, components, and typical applications.—Barnes & Jones, Inc., 206 Eustis St., Boston 19, Mass.

U-732 **Diesel-engine Pyrometer.** 2-page Bulletin P-1247 illustrates and describes new portable diesel-engine pyrometer for checking cylinder and exhaust temperatures. Includes features and specifications.—The Bristol Co., Waterbury, Conn.

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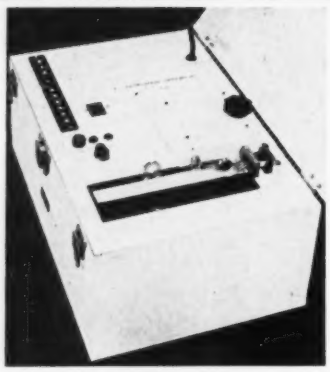
Write for New Bulletin 16-1, "Honeywell Pressure Pilot."



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NEW LITERATURE

Pressure

U-733 **Pressure Gages.** 4-page Specification Sheet 708 illustrates and describes makers indicating and recording pressure gages. Includes specifications, features, models, and engineering details.—Minneapolis-Honeywell Regulator Co., Industrial Div., Sta. 40, Wayne & Windrim Aves., Phila. 44, Penna.

U-734 **Manometers.** 12-page illustrated "Manual On Manometers" explains manometer principles and gives detailed data on installation, operation, reading, and maintenance. Tables of equivalents are given for various liquids, together with correction factors. —King Engineering Corp., Box 510, Ann Arbor, Mich.

U-735 **Multi-pointer Gages.** 4-page Product Specification M 42-1 illustrates and describes maker's diaphragm-operated multi-pointer indicator gages for draft and pressure, and Bourdon-tube units for temperatures and high pressures. Includes specifications.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

U-736 **Recorders for Pressure, Temperature.** 4-page General Specification CM 060 A illustrates and describes maker's line of recorders, including actuating mechanisms for pressure, draft, and temperature.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

U-737 **Pressures in Instrument Lines.** 24-page issue No. 22 of "Instrument Notes" features reprint of article "Attenuation of Oscillatory Pressures in Instrument Lines" by A. S. Iberall of NBS.—Statham Laboratories, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Flow

U-738 **Electronic Flow Meter.** 4-page Instrumentation Data Sheet 10.3-5 illustrates and describes "Potter-Brown Electronic Flow Meter," which consists of "Potter" rotor-type sensing unit and "Electronik" indicator-integrator unit. Includes features and typical applications over wide range of temperatures and pressures.—Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 213, Wayne & Windrim Aves., Phila. 44, Penna.

U-739 **Well-mud Flow Meter.** 4-page Instrumentation Data Sheet 7.0-4 illustrates and describes Shand and Jurs method for measuring mud level and mud flow for oil-well drilling. Includes principles, components, and applications. —Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 213, Wayne & Windrim Aves., Phila. 44, Penna.

U-740 **Flow Regulators.** 4-page Bulletin 521 covers principles, features, and typical applications of maker's direct-acting flow-rate regulators.—W. A. Kates Co., 430 Waukegon Rd., Deerfie'd, Ill.

U-741 **Water Meters.** 20-page Vol. 36 No. 3 issue of "The Rockwell Water Journal" describes maker's line of water meters and articles on sewage treatment and waterworks systems.—Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Penna.

U-742 **Electromagnetic Pump.** 2-page Bulletin GEC-876 illustrates and describes new a-c. electromagnetic pump with no moving parts for pumping liquid metals and conducting fluids. Includes principle, features, operation, and specifications.—General Electric, Schenectady, N. Y.

U-743 **Metering Pump.** 16-page illustrated brochure presents the "Corson-Cerveny Micro-Bellows Pump" for precision metering applications. Includes construction, features, and applications.—Research Appliance Co., Box 413 West View Rd., Pittsburgh 9, Penna.

U-744 **Orifice Plates.** 4-page Bulletin 54-C covers maker's machined orifice plates.—Industrial Instrument Corp., Odessa, Texas.

U745 **Water Level.** 4-page No. 37 issue of "the Hydromike" describes "Telemark" for r-f. signalling of level of water in rivers, reservoirs, tanks, etc., in response to inquiring r-f. signals.—Leupold & Stevens Instruments, Inc., 4445 N.E. Glison St., Portland 13, Oregon.

Process Control

U-746 **Program Controllers.** 8-page illustrated Bulletin 1501 describes "ElectroniK Strip Chart Program Controllers" with electric-set-point index drive, used for automatic regulation of time-temperature control programs in metal processing and other industries. Includes models available, construction details, typical applications, specifications, dimensions and data on auxiliary equipment.—Sta. 213, Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne & Windrim Aves., Phila. 44, Penna.

U-747 **Program Controllers.** 8-page illustrated Bulletin 1502 covers "ElectroniK" cam-operated program controllers with electric-contact, electric-proportional, and pneumatic control actions.—Minneapolis-Honeywell Regulator Co., Industrial Div., Sta. 213, Wayne & Windrim Aves., Phila. 44, Penna.

U-748 **Miniature Control Equipment.** 16-page Bulletin BG 040-2 illustrates and describes line of "Bailey Mini-Line" compact controllers and indicators for control stations of power and industrial plants. Includes features and typical applications.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

U-749 **Program Controller.** Illustrated Catalog Sheet 125 covers features and operation of new "Timed Operations Preselector" which delivers repetitious fixed timing impulses for process control.—The Henry G. Dietz Co., 12-16 Astoria Blvd., L.I. 2, N. Y.

U-750 **Autotransformer Control System.** 2-page Instrumentation Data Sheet 11.3-5 illustrates and describes flexible control system for furnaces, conveyors, etc., which uses "Electronik" controller, "Electr-O-Line" relay, and "Powerstat" variable transformer. Includes principles, components, and operation.—Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 40, Wayne & Windrim Aves., Phila. 44, Penna.

U-751 **Control Equipment.** 26-page brochure entitled "Controls" contain 11

data bulletins on control equipment, including vane-type air-flow switch, program controller, pressure switch, static-pressure controls, differential static pressure and vacuum controls, electronic controls, and tape-disk recorder.—Henry G. Dietz Co., 12-16 Astoria Blvd., L. I. 2, N. Y.

Panelboards

U-752 Instrument Panelboards. 4-page Bulletin 143 illustrates formed aluminum, steel, and other products made to specifications of many industrial users.—Falstrom Co., 99 Falstrom Court, Passaic, N. J.

U-753 Control Panels. 8-page illustrated Bulletin 170 covers maker's facilities for custom-engineered control panels. Includes features and typical applications.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

U-754 Control Panels. 8-page Bulletin F5265 illustrates and describes technique for designing heating and air-conditioning control systems using a central control panel. Includes features and typical diagrams.—Barber Colman Co., Rockford, Ill.

Steam and Power

U-755 Instruments for Power Generation. 44-page Catalog 902, "Supervisory Instruments for Power Generation," covers instrumentation involved in power-generating stations, including measurement of temperature, pressure, flow, power generation, and other variables encountered. Includes steam generation, turbines and generators, electrical distribution, and diesel-engine instrumentation.—Sta. 40, Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne & Windrim Aves., Phila. 44, Penna.

U-756 Smoke and Combustion Indicator. 4-page Bulletin 5101 illustrates and describes "Wyd-Angle" smoke periscope with 90-degree vision angle and "Cat's Eye" furnace indicator. Includes diagrams, principles, and operation.—Ess Specialty Corp., 96 S. Washington Ave., Bergenfield, N. J.

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Air

U-757 Dehumidifiers. 32-page illustrated Bulletin 222 entitled "Because Moisture Isn't Pink" describes principles, advantages, and operation of maker's "Lectrodryer" equipment for drying air, gases, and organic liquids to low dewpoints. Includes 70 actual applications in manufacturing, instrumentation, etc.—Pittsburgh Lectrodryer Corp., P. O. Box 1766, Pittsburgh 30, Penna.

U-758 Air and Gas Cleaners. 4-page illustrated Bulletin SC-1007 describes principles, features, and typical applications of maker's "Liqui-Jectors" for removing water, oil emulsions, and dirt from compressed air or gas lines. 2-page Bulletin SC-1008 covers "Series B Liqui-Jectors" for from 100 to 500 cfm.—Selas Corp. of America, Phila. 34, Penna.

U-759 Pneumatic Calibrator. 4-page Form 52-3 illustrates and describes new calibrator for testing instruments operating between 0 and 20 inches of water—vacuum, pressure, or compound. Includes features, specifications, and operation.—Republic Flow Meters Co., 2240 Diversey Pkway, Chicago 47, Ill.

U-760 Sludge and Aeration Instrumentation. 4-page Application Engineering Data Sheet 833-9 describes how modern instrumentation controls air and sludge in activated sludge plants. Includes system diagrams and instrument specifications.—The Foxboro Co., Foxboro, Mass.

Radioactivity

U-761 Radioactivity Instruments. 12-page illustrated condensed Catalog L contains descriptions of maker's large line of radiation instruments and radiochemicals. Includes monitors, scalers, counters, radiochemicals, and accessories.—Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago 10, Ill.

U-762 Radiation Monitor. 4-page illustrated bulletin describes new "Radector" portable gamma-ray detector. Includes features and specifications.—Jordan Electronic Sales, Inc., Culver City, Calif.

Optical

U-763 Polarized Light. Folder entitled "Technical Information" contains (1) 52-page booklet "Polarized Light and its Applications," and (2) 4-page No. 3 issue of the "Polaroid Reporter." Includes history, principles, operation, and applications of maker's light-polarizing materials.—Polaroid Corp., Cambridge 39, Mass.

U-764 Optical Instruments. 16-page folder illustrates and describes 23 models of "Reichert" Austrian-made microscopes for biology, metallography, photo-micrography, etc. Brief descriptions are in four languages— German, English, French, and Spanish.—Wm. J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

U-765 Camera Microscope. 6-page illustrated brochure describes "Reichert" Austrian-made universal camera microscope, including features and applications.—Wm. J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

U-766 Polarimeter. 7-page brochure covers "Reichert" Austrian-made polarimeter, including features, operation, and accessories.—Wm. J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

U-767 Magnifiers. 24-page Bulletin I-67, titled "Industrial Magnifiers—How to Choose and Use Them," outlines optical principles of magnifiers, describes basic types, tells how to use and care for them, and includes a magnifier selector chart and glossary.—Bausch & Lomb Optical Co., Rochester 2, N. Y.

U-768 Headband Magnifier. 2-page brochure illustrates and describes features of "Zeiss" binocular headband magnifier for all close work.—Carl Zeiss, Inc., 485 5th Ave., New York 17, N. Y.

Chemical Laboratory

U-769 Research Instruments. 104-page Bulletin 15-14, "Instruments Accelerate Research," covers principles and applications of latest laboratory and analytical instruments—spectrometers, polarographs, gas analyzers, potentiometers, vacuum gages, force transducers, etc.—Minneapolis-Honeywell Regulator Co., Sta. 40, Brown Instruments Div., Wayne & Windrim Aves., Phila. 44, Penna.

U-770 Viscometers. 8-page illustrated Bulletin V-1000 C describes principles, features, and operation of maker's plunger-type viscometer for recording and controlling viscosity in industrial applications.—Norcross Corp., Newton 58, Mass.

U-771 Glossmeter and Colorimeter. 4-page illustrated brochure covers features of maker's portable glossmeter. 2-page Catalog sheet 925 illustrates and describes "Hellige Chromatron" photoelectric colorimeter and turbidimeter.—Gardner Laboratory, Inc., Bethesda 14, Md.

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NEW LITERATURE

U-772 **Laboratory Equipment.** 4-page illustrated Bulletin D-2911 describes "Temcometer" controller pyrometer, "Coleman" photo-nephelometer, analytical balances, laboratory microscopes, etc.—Harshaw Scientific, 1945 E. 97th St., Cleveland 6, Ohio.

U-773 **Sterile Cabinet.** 6-page folder illustrates and describes dust-free, sterile "Sterilshield" cabinet for precision assembly and research.—The Baker Co., Maplewood, Maine.

U-774 **Combustion-tube Furnaces.** 4-page illustrated Bulletin LAB-552 covers maker's line of combustion-tube furnaces for carbon determination, organic analysis, etc. Includes features, specifications, and multiple units.—Hevi Duty Electric Co., Milwaukee 1, Wis.

Chemical Process Analysis

U-775 **Recording Microphotometers.** 4-page Instrumentation Data Sheet 10.16—16 describes "Jarrell-Ash" recording microphotometer with "Brown Electronik" recorder for spectra studies. Includes principles, applications, and specifications of 2-second-speed potentiometer.—Minneapolis-Honeywell Regulator Co., Industrial Div., Sta. 213, Wayne & Windrim Aves., Phila. 44, Penna.

U-776 **X-ray Fluorescence Analysis.** 4-page reprint of article describes principles and uses of x-ray-fluorescence Geiger-counter method for rapid, quantitative non-destructive analysis of high-alloy steels and alloys of chromium-nickel-cobalt type.—North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

U-777 **Infrared Spectrophotometry.** 12-page Vol. 3 No. 2 issue of "Better Analysis" features articles on applications of infrared spectrophotometry in various chemical and industrial process, including steel manufacturing.—Baird Associates, Inc., 33 University Rd., Cambridge 38, Mass.

U-778 **Spectroscopic Analysis of Iron Alloy Slags.** 4-page Vol. 5 No. 2 issue of "ARL Spectrographer's News Letter" features article on "Quantometric Analysis of Iron Alloy Slags." Also technical tips on spectrograph operation.—Applied Research Laboratories, Glendale 5, Calif.

Safety Signalling

U-779 **Safety Signalling Systems.** 4-page illustrated Bulletin 440 covers maker's unitized annunciator systems for safety signalling in plants and processes. Includes descriptions of hermetically sealed plug-in relay unit and cabinet dimensions. Data sheet shows standard circuit sequences.—Tigerman Engineering Co., 4332 N. Western Ave., Chicago 18, Ill.

U-780 **Alarm-silencing Relay.** 2-page illustrated Bulletin 8501 describes new relay for silencing alarm in signalling circuits, resetting alarm, and indicating that alarm has been sounded. Includes wiring diagram, dimensions, and installation data.—Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 40, Wayne & Windrim Aves., Phila. 44, Penna.

Telemetering

U-781 **Telemetering.** 24-page illustrated brochure "Standard Telemetering Receiving Stations and Associated Components" covers maker's FM/FM multi-channel telemetering systems. 14-page brochure "Model THC-1 Electronic Decommutator" covers equipment for separation of up to 27 channels on one commutated subcarrier.— Pacific Div., Bendix Aviation Corp., 166 W. Olive Ave., Burbank, Calif.

U-782 **Multi-channel Telemetering System.** 8-page Vol. 1 No. 5 issue of "The Lenkurt Demodulator" features article on engineering features of the new "Type 33C" carrier telephone system with 24 toll-quality voice channels. Also nomograph of loss between r-f. transmitters and receivers.— Lenkurt Electric Co., San Carlos, Calif.

Computers

U-783 **Digital Computer.** 6-page illustrated brochure covers maker's "CRC 102" general-purpose digital computer for mathematical problems. Includes features, operation, and typical solution. Data sheet announces addition of I.B.M. card input and output.—Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif.

U-784 **Analog Computer.** 12-page illustrated brochure covers maker's electronic analog computer. Includes principles, features, operation, applications, and descriptions and specifications of basic components and associated equipment.—Boeing Airplane Co., Seattle 14, Wash.

U-785 **Analog Computers.** 4-page issue No. 1 of "The Lightning Empiricist" features articles on (1) maker's "GAP/R" analog-computer components, (2) the analog in governor design, and (3) triodes as n-th power elements. Also bibliography on analog computers.—Geo. A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Servomechanisms

U-786 **Servomechanism Components.** 16-page illustrated Brochure MDA-200 describes complete line of precision components for rapid and economical assembly of control-system instruments and analog computers for breadboard and semi-permanent assembly. Includes new components such as lead-screw unit, clutch, bevel gears, limit stop, dials, cams, etc.—Servomechanisms, Inc., Post and Stewart Aves., Westbury, L. I., N. Y.

Tachometers

U-787 **Tachometers.** 2-page illustrated brochure covers features and specifications of new "O-Z" single-range and universal hand tachometers.—O. Zernickow Co., 15 Park Row, New York 38, N. Y.

U-788 **Tachometer Kit.** 4-page illustrated Brochure GEC-816 describes new GE tachometer kit consisting of tachometer generator, web-break detector, indicator and recorder. Includes features, applications, and specifications.—General Electric, Schenectady, N. Y.

U-789 **Tachometers.** 2-page illustrated Bulletin 12AA illustrates and describes 1-, 3-, and 5-range hand tachometers; also chronometric speed indicators. Includes features and models.—Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.

U-790 **Tachometers.** 4-page Technical Data Sheet T4 covers principle of operation and features of maker's hand, portable, and fixed generator-type tachometers. Includes circuit diagrams.—Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

U-791 **Tachometer Heads.** 2-page illustrated Technical Data Sheets 56M and 57M cover maker's heavy-duty tachometer heads for measuring rotational or linear speeds.—Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

Testing and Inspection

U-792 **Pneumatic Comparator Gages.** 8-page Bulletin 8005-S illustrates and describes maker's line of pneumatic comparator gages. Includes principles, installation, operation, and maintenance.—Moore Products Co., Phila. 24, Penna.

U-793 **Gaging Controller.** 8-page illustrated brochure describes maker's "Electricator Models 134 and 131" for gaging and signalling. Includes features and applications as comparator, multiple dimension gage, machine control

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U-794 **Air Gages.** 8-page illustrated folder and 4-page Vol. 2 No. 4 issue of "Federal Methods of Measurement" describe maker's "Dimensionair" air gages for precision gaging. Includes principles, operation, and applications.—Federal Products Corp., 1144 Eddy St., Providence, R. I.

U-795 **Surface Roughness.** Illustrated wall chart, 11 x 17 inches, gives tabular listing of 7 standard "Profilometer Tractors," types and dimensions of internal and external surfaces that can be measured, and types of piloting used. Includes typical applications. Write on company letterhead to—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

U-796 **Universal Testing Machines.** 18-page Bulletin 43 covers principles, operation, detailed descriptions and typical applications of maker's electromechanical universal testing machines, proving rings, and accessories. 4-page Bulletin 44 covers "Standard L" hydraulic testing machine. 2-page Bulletin 45 covers "Twist O Test" holders. 8-page Vol. 3 No. 1 issue of "Tinius Talks" covers new 400,000-lb. "Super L" machine. 6-page Vol. 4 No. 1 issue of "Tinius Talks" announces deluxe model "Super L" machine.—Tinius Olsen Testing Machine Co., Easton Rd., Willow Grove, Penna.

U-797 **Laboratory Testing Devices.** 2-page Bulletin 111 contains brief description of thickness gage, viscosity cup stand, washability machine, immersion pump, moisture meter, sand abraser, and microscope lamp.—Gardner Laboratory, Inc., Bethesda 14, Md.

U-798 **Ball-bearing Torque Tester.** 2-page Bulletin GEA-5822.3 illustrates and describes new ball-bearing torque tester. Includes operation, description, and specifications.—The Baker Co., Maplewood, Maine.

U-799 **Aircraft Test Equipment.** 8-page brochure illustrates and describes maker's aircraft test equipment and special hydraulic items, including pump test stands, hydraulic test stands, cabin leakage tester, and hydraulic boost pumps. Seven data sheets contain specifications on each device. 5-page brochure covers new hydraulic air-operated pump.—Sprague Engineering & Labs., 1144 W. 135 St., Gardena, Calif.

Tubing & Fittings

U-800 **Steel Fittings.** 24-page illustrated Form E-1457A describes maker's large line of steel and stainless-steel flareless fittings. Includes features, operation, typical applications, and detailed specifications.—The Weatherhead Co., Cleveland 8, Ohio.

U-801 **Aluminum Fittings.** 4-page illustrated Bulletin 4316B2 describes 12 "Triple-lok" aluminum tube fittings now available, and describes hydraulic and fluid-handling applications where aluminum-tubed systems can be used.—The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

U-802 **Hydrostatic-tube Tester.** 4-page illustrated brochure describes new hydrostatic tube-testing machine and

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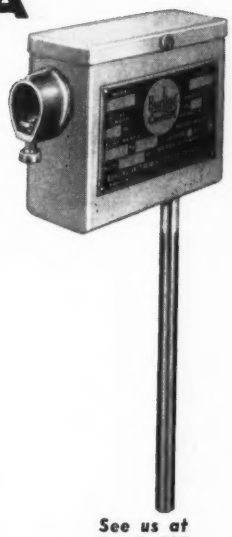

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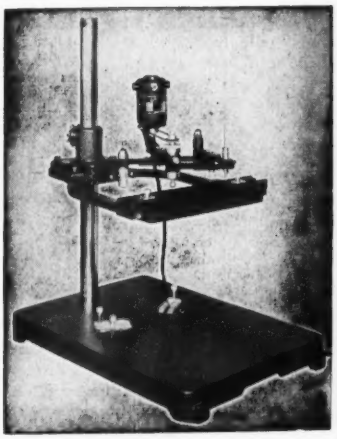

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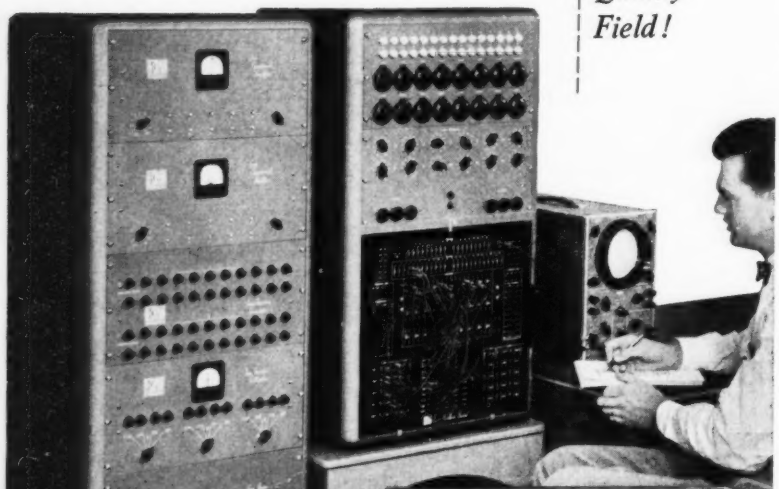

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NEW LITERATURE

maker's line of hydraulic presses.—Dorr-Pattersen Engineering Co., 241 Chene St., Detroit 7, Mich.

Valves

U-803 **Diaphragm-motor Valves.** 6-page illustrated Specification Sheet 408-3 covers "Honeywell Series 700 Low-Flow Diaphragm Motor Valves" for wide-proportional-band control. Includes inner valve types, actuator specifications, flow coefficients, and design features.—Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 40, Wayne & Windrim Aves., Phila. 44, Penna.

U-804 **Control Valves.** Revised edition of Diaphragm Control Valve Section 105 gives photographs, sectional drawings, and dimensions of maker's new or redesigned items. Includes new "Type 87" valve with bellows-sealed stem, new outlet diaphragm control valve, and new "1486" 3-way diaphragm control valve.—Black, Sivalls, & Bryson, Inc., 7500 E. 12th St., Kansas City 3, Mo.

U-805 **Miniature Valves and Controllers.** 4-page illustrated brochure covers features, performance, and ratings of maker's line of "Minim" diaphragm-operated miniature (⅛ to ½ inch) control valves. Also brief descriptions of miniature positioners, flow and level controllers, pinch valves, and air motors. Charts give trim size for various valves.—Research Control Instruments Co., 7306 E. 11th St., Tulsa, Okla.

U-806 **Precision Check Valves.** 4-page illustrated brochure covers features, operation, and technical characteristics of maker's "Circle Seal" check valves for from 0 to 3000 psi. and 65 to 280 deg. F.—James-Pond-Clark, Pasadena 1, Calif.

U-807 **Push Valve.** 2-page illustrated Bulletin 304 describes new non-leaking self-closing push valve for manual control of air or gas. Includes features, applications, and specifications.—King Engineering Corp., Ann Arbor, Mich.

U-808 **Neutral Valves.** 8-page illustrated bulletin "Section 11" covers maker's new "status quo" and "spring-centered" neutral valves with all ports blocked in neutral position. Includes models and specifications.—Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

High-speed Recording

U-809 **Oscillograph Recording.** 12-page Vol. 6 No. 2 issue of "CEC Recordings" features articles on helicopter flight testing with use of oscillograph recording, coal-to-oil conversion, high-speed recording tests of generator, and others.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

U-810 **Recording Oscilloscope.** 4-page illustrated Bulletin 11-9090 describes new "Memoscope" recording oscilloscope with 4 turn tables, magnetic recorder, electronic synchronizing, FM

recording, etc. Includes features and specifications.—Millivac Instrument Corp., P O Box 997, Schenectady, N. Y.

U-811 **Direct-writing Recorders.** 16-page Brochure 23 M-6-52 entitled "7 Advantages of Sanborn direct-writing Recorders" illustrates and describes 7 features of maker's inkless, heat-stylus-ribbon recorders.—Sanborn Co., Industrial Div., Cambridge 39, Mass.

U-812 **Ferromagnetography.** 64-page July issue of "General Electric Review" features articles on high-speed printing with shaped magnetic fields (ferromagnetography) and "Type G10" germanium rectifier with low forward resistance and high back resistance.—General Electric, Schenectady, N. Y.

U-813 **Tape Splicer.** Bulletin illustrates and describes new "MT-1 Presto-Splicer" for rapid splicing of ¼-inch acetate recording tape.—Prestoseal Mfg. Corp., New York, N. Y.

Power Supplies

U-814 **Power Supplies.** 44-page catalog contains 19 illustrated data sheets, each describing one model of maker's line of regulated power supplies. Includes features and specifications.—Kepco Laboratories, Inc., 131 Sanford Ave., Flushing 55, N. Y.

U-815 **Power Supplies.** 16-page illustrated Catalog E651 contains principles, features, operation, and specifications of maker's line of "Nobatron" low-voltage high-current regulated d-c. supplies, and "B-Nobatron" high-voltage low-current regulated d-c. supplies; includes typical applications. 4-page Condensed Standard Specifications lists specifications on all models in condensed form.—Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.

U-816 **Line Regulators.** 8-page Vol. 5 No. 3 issue of "Currently" features 6-page article on a-c. line regulation. Specifications are given for "Model 1001" a-c. line regulator and for "Model E-6/2-5" d-c. power source for spectrophotometers.—Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.

U-817 **Vibrator Converters.** 2-page Instrumentation Data Sheet 10.20-5 covers maker's line of 60-cycle a.c.-d.c. converters. Includes principles, design, applications, and characteristics.—Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 213, Wayne & Windrim Aves., Phila 44, Penna.

U-818 **Converters and Alternators.** 16-page Catalog 452 illustrates and describes maker's line of converters for converting d.c. to 60-cps. a.c., and inductor alternators for changing d.c. to 400/800-cps. a.c. Includes selector and performance charts.—Carter Motor Co., 2644 N. Maplewood Ave., Chicago 47, Ill.

U-819 **Shielded Power Transformers.** 2-page Bulletin 11-1246 illustrates and describes new "Lofyld" power transformer for quality amplifiers, which uses toroid-wound shielded windings for minimum radiation. Includes principles and specifications.—Millivac Instrument Corp., P. O. Box 997, Schenectady, N. Y.

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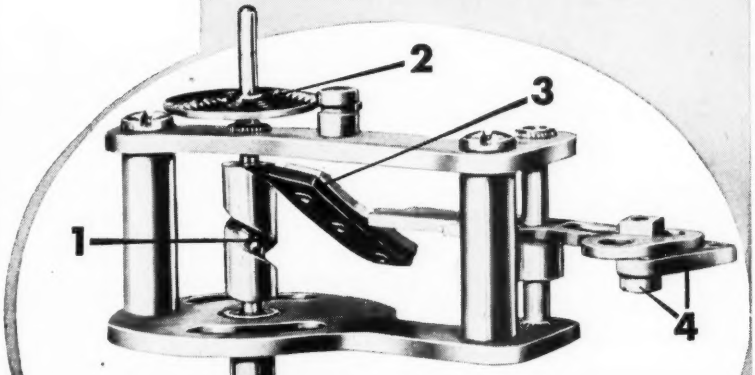

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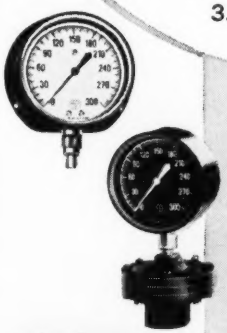

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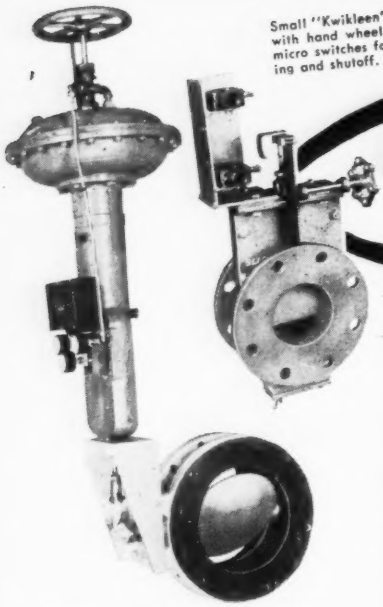

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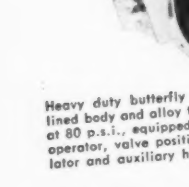

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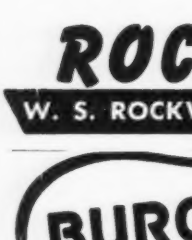

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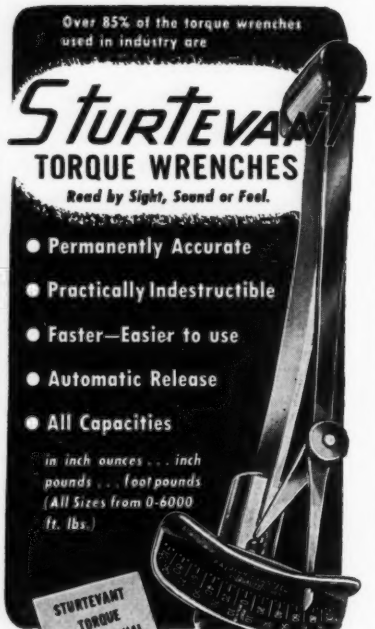

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NEW LITERATURE

Electrical & Electronic Test Instruments

U-820 **Test Equipment.** 4-page illustrated brochure describes maker's line of audio-frequency test equipment, including new intermodulation meter, flutter meter, and tape distortion meter. Includes features and specifications.—D & R Ltd., 402 E. Gutierrez St., Santa Barbara, Calif.

U-821 **Test Equipment,** 4-page Vol. 8 No. 2 issue of "Allied News" features illustrated descriptions of test equipment handled by large mid-west distributor, including new "Ampex" tape recorders, and "G E" tube analyzers for industrial rectifiers.—Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

U-822 **Test Instruments.** 8-page brochure illustrates and describes maker's line of test instruments supplied in kit form. Includes VTVM, oscilloscope, amplifiers, signal generators, analyzers, probes, etc.—Heath Co., Benton Harbor, Mich.

U-823 **Electronic Wattmeter.** 2-page illustrated brochure describes uses, features, principle, and specifications of new "Model 109" electronic wattmeter with response from 20 to 3000 cps.—Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.

U-824 **Oscilloscopes.** 4-page illustrated brochure covers features and specifications of maker's line of "Pulsescopes" for video-pulse observation and "Pocketscopes" for observation of repetitive signals.—Waterman Products Co., Inc., 2445-63 Emerald St., Phila. 25, Penna.

U-825 **Power-frequency Amplifier.** 2-page bulletin illustrates and describes new "Model 105 Meter Matcher" power-frequency amplifier with high input-impedance and low output-impedance. Includes principles, specifications, and applications with wattmeter or voltmeter.—Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.

U-826 **Frequency Meter.** Data Bulletin FM-3 illustrates and describes "Model FM-3" direct-reading VHF frequency meter with range from 20 to 640 Mc. Includes performance data.—Gertsch Products, Inc., 11846 Mississippi Ave., Los Angeles 25, Calif.

U-827 **Welding Analyzer.** 2-page illustrated Form 841 covers components, functions, and specifications of new welding analyzer that records welding current, electrode force, and other variables in both single-phase and 3-phase resistance welding.—Brush Development Co., Instrument Div., 33 F, 3405 Perkins Ave., Cleveland 14, Ohio.

U-828 **Motor and Circuit Tester.** 2-page illustrated bulletin covers new "H-B" indicator for testing motors, solenoids, magnetic fields, flux patterns, etc. Includes applications and operation details.—H-B Indicator Co., 915-B Terminal Sales Bldg., Seattle 1, Wash.

U-829 **UHF Signal Generators.** 4-page Vol. 3. No. 9-10 issue of "hp Journal" describes maker's direct-reading

UHF signal generators for from 800 to 4000 Mc. Includes principles, schematic, and specifications.—The Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

U-830 **Waveform and Pulse Generators.** 4-page brochures give general descriptions and characteristics of new special-waveform and pulse generators. Includes gate and pulse characteristics. —Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.

U-831 **A-c. Measureents.** 2-page illustrated Instrumentation Data Sheet 9.1-13 describes use, operation, and advantages of continuous wide-chart recording of alternating voltage or current by means of Weston thermal converter and "Electronik" potentiometer. —Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Sta. 40, Wayne & Windrim Aves., Phila. 44, Penna.

U-832 **R-f. Equipment.** 10-page illustrated brochure covers maker's r-f. and video attenuators, impedance-matching networks, line pads, distribution networks, etc. Includes features and specifications.—The Daven Co., Dept. R F, 191 Central Ave., Newark 4, N. J.

Electrical & Electronic Components

U-833 **Electronic Components.** 20-page Stock Catalog No. 24 illustrates and describes maker's large line of rheostat-potentiometers, resistors, tap switches, chokes, lugs, resistance boxes, knobs, and dials.—Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.

U-834 **Capacitors and Vibrators.** 16-page Vol. 17 No. 6 issue of "The CD Capacitor" features article on use of signal generator with marker generator. Also descriptions of maker's ceramic disk capacitors and seal-vent vibrators. —Cornell-Dubilier Electric Corp., Hamilton Blvd., So. Plainfield, N. J.

U-835 **Selenium Rectifiers.** 10-page brochure contains catalog sheets of maker's line of high-power selenium-rectifier units for electroplating, anodizing, and other d-c. industrial applications.—Richardson-Allen Corp., College Point, N. Y.

U-836 **Transformers.** 24-page catalog and replacement guide contains over 500 listings of transformers and related components. Includes television component section, numerical index, classified index, and separate sections for high fidelity, input and interstage, output, driver, modulation, power, filter transformers.—Standard Transformer chokes, plate, isolation and autoformer Corp., 3580 Elston Ave., Chicago, Ill.

U-837 **Ferrite-core Transformers.** 4-page illustrated Form SA14 describes new transformer-engineering techniques utilizing ferrite cores to obtain high permeability, high efficiency, broad bandwidth, and high power. Includes principles, specifications, and typical applications.—Sierra Electronic Corp., San Carlos, Calif.

U-838 **Powder-iron Cores.** 8-page illustrated Form IC-P8 describes maker's powder-iron cores and asemblies—tuning cores, plain cores, pot cores, and cup cores. Includes specifications,

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NEW LITERATURE

performance, and characteristics.—Lenkurt Electric Co., 1117 County Rd., San Carlos, Calif.

U-839 **Rheostats and Resistors.** 2-page May-June issue of "The Ohmite News" features descriptions of field-control rheostats and low-wattage resistors.—Ohmite Mfg. Co., 4835 Flournoy St., Chicago 44, Ill.

U-840 **Multi-contact Connectors.** 32-page Audio-Type Connector Bulletin No. PO4-1952 adds new and improved connector types for microphone, public address, and low-level sound applications. Includes all pertinent engineering data on Type Series P, O, X, XK, XL, BRS, BG, and UA.—Cannon Electric, P O Box 75, Lincoln Heights Sta., Los Angeles 31, Calif.

U-841 **Multi-contact Connectors.** 8-page illustrated "Type AO Bulletin" describes new "Type AO Series" of heavy-duty connectors made to Army Ordnance specifications.—Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

U-842 **Multi-contact Connectors.** 4-page Vol. 5 No. 5 issue of "Amphenol Engineering News" features articles on high-voltage connectors and applications of connectors in various instruments.—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

U-843 **Binding Posts.** 4-page Form 6501 illustrates and describes new 5-way binding posts, including features and applications.—The Superior Electric Co., Bristol, Conn.

U-844 **Low-mu Triode.** Data sheet describes "Los Gatos Type 250 T L" low-mu triode. Includes characteristics, constant-current curves, specifications, and typical operation as class-B and class-C power amplifier, oscillator, etc. —Lewis & Kaufman, Inc., 110 El Rancho Ave., Los Gatos, Calif.

U-845 **Klystrons.** 4-page illustrated brochure covers features and models of maker's line of Klystrons for local oscillators and transmitter tubes. Includes equipment and facilities for nuclear-resonance studies.—Varian Associates, 990 Varian St., San Carlos, Calif.

U-846 **Piezoelectric Microphones.** 8-page June issue of "Brush Strokes" features 6-page article on design considerations of piezoelectric microphones, crystal and ceramic. Also described is new "Model BL-2105" frequency analyzer.—The Brush Development Co., 3322 Perkins Ave., Cleveland, Ohio.

U-847 **Delay Lines.** Illustrated data sheets describe features and specifications of new (1) "Type 506" miniature continuously variable (from 0 to 0.225 usec.) delay line and (2) "Type 302" continuously variable (from 0 to 0.6 usec.) delay line.—Advance Electronics Co., P. O. Box 394, Passaic, N. J.

U-848 **Precision Switches.** 8-page illustrated Form A-84-55 contains descriptions of maker's "Micro" line of precision switches and reprint of article on use of switches in aviation applications.—Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill.

U-849 **Mercury Safety Switches.** 2-page illustrated Bulletin 800 M covers features and specifications of maker's line of mercury safety switches for hazardous and explosive areas.—Tigerman Engineering Co., 4332 N. Western Ave., Chicago 18, Ill.

U-850 **Plug-in Socket Turrets.** 8-page illustrated brochure covers maker's new line of socket turrets whereby circuit components can be wired directly to tube socket. Includes types, features, and applications.—Vector Electronic Co., 3352 San Fernando Rd., Los Angeles 65, Calif.

U-851 **Stepping Relays and Solenoids.** 4-page illustrated Bulletin 150 describes line of circuit selectors and stepping relays with remote rotary-solenoid control. 4-page Bulletin 351 describes features and applications of line of rotary solenoids.—G. H. Leland, Inc., Dayton 2, Ohio.

U-852 **Plastic Knobs, Strips, etc.** 4-page 1952 catalog illustrates and describes 36 groups of plastic knobs, handles, terminal strips, etc. Includes detailed specifications.—Dimco-Gray Co., 207 E. 6th St., Dayton 2, Ohio.

U-853—**Fractional-hp Motors.** 4-page Vol. 32 No. 4 issue of "The Bodine Motorgram" features article on temperature ratings of motors. Also application of maker's motors in automatic check signer.—Bodine Electric Co., 2244 W. Ohio St., Chicago 12, Ill.

Miscellaneous

U-854 **Ultrasonic Generator.** 2-page illustrated Bulletin GEC-544 A describes maker's piezoelectric-type ultrasonic generator for physical and chemical applications. Includes description, features, and specifications.—General Electric, Schenectady, N. Y.

U-855 **Strain Measurement.** 12-page Vol. 2 No. 2 issue of "Hathaway Engineering News" contains articles on strain measurements, tuning-fork frequency standards, d-c. amplifiers, and foundry for an instrument factory.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.

U-856 **Magnet for Non-ferrous Metals.** 4-page folder illustrates and describes new "Meta-Magnet" for attracting silver, aluminum, gold, brass, magnesium, and non-ferrous metals.—Meta-Magnet Associates, P. O. Box 3664, Orlando, Fla.

U-857 **Instrument Bearings.** 4-page Bulletin 52-R describes maker's non-freezing precision instrument bearings for orifice meters, controllers, etc.—Industrial Instrument Corp., Odessa, Texas.

U-858 **Miniature Counter.** 2-page illustrated brochure describes new solenoid-operated miniature 2-ounce-weight "Model CE-A24D" counter. Includes features, specifications, and typical applications.—Abrams Instrument Corp., Lansing 1, Mich.

U-859 **Engraving Machines.** 6-page folder Bulletin B-1 illustrates and describes maker's line of engraving machines and accessories, including "Electro-Marker" cutter-grinder, work table, and endless belts.—H. P. Preis Engraving Machine Co., Hillsdale, N. J.

ADVERTISERS' INDEX

Acragage Co. 1156
Acromark Company 1054
Airborne Instruments Laboratory 1060
Alina Corporation 1149
Allied Radio Corp. 1152
American Chain & Cable Co. 1171
American Instrument Co., Inc. 1035
American Machine & Metals, Inc. 991, 1019
American Meter Co. 955
American Phenolic Corp. 1154
American Time Products, Inc. 932
American Tradair Corp. 1131
Amglo Corporation 1134
Amthor Testing Instrument Co. 1052
Analytical Measurements, Inc. 1164
Annin Company 997
Arnold Engineering Co. 1004
Arrow Electronics Inc. 1065
Askania Regulator Company 1013
Assembly Products, Inc. 1162
Atkomatic Valve Co. 1142
Atlas Valve Company 1175
Automatic Electric Sales Corporation 1071
Automatic Switch 1147

Bailey Meter Co. 1126, 1148, 1159
Baker Company 1058, 1157
Barksdale Valves 979
Barton Instrument Corp. 1157
Beckman Instruments Inc. 1170
Beckman & Whitley Inc. 1053
Bendix Aviation Corp. 1061
Bethlehem Apparatus Co., Inc. 1159
B & F Instruments, Inc. 1054
Biddle Co., James G. 957, 958
Black, Sivalls & Bryson, Inc. 965
Borg Corp., George W. 1054, 1055
Bowser, Inc. 954
Bridgeport Thermostat Div. 1007
Bristol Co. 974-975
Brookfield Engineering Laboratories, Inc. 1146
Brown Electro-Measurement Corp. 1070
Brown Instruments Div., Minneapolis-Honeywell Regulator Company 1070
Brush Development Co. 969
Buffalo Meter Co. 1056
Burgess Battery Company 1056, 1172
Burke & James, Inc. 1162
Burling Instrument Co. 1169
Burlington Instrument Co. 1070

Cambridge Instrument Co., Inc. 1137
Cannon Electric Co. 1032
Carboloy Dept. of General Electric Company 980-981
Century Geophysical Corp. 1033
C. G. S. Laboratories, Inc. 1057
Chace Co., W. M. 1049
Collins Microflat Co. 1046
Consolidated Engineering Corp. 962
Crawford Fitting Co. 1037

Daven Co. 1137
Davis Emergency Equipment Co., Inc. 1061
De Jur Amsco Corporation 1026
De Zurik Shower Company 1146
Dial Light Co. of America 1069
Dimco-Gray Company 1073
Doelcam Corporation 1053
Dragon Engineering Company 1055
DuMont Labs., Inc., Allen B. 972
du Pont de Nemours & Co., Inc., E. I. 1139

Eagle Signal Corp. 978
Edin Company 1066
Edison, Inc., Thomas A. 1039
Electric Auto-Lite Co. 1068
Electric Indicator Co. 1034
Electro-Medical Laboratory, Inc. 1166
Electro Products Laboratories 1028
Electronic Engineering Associates 1143
Ellison Draft Gage Co. 1071
Emery Co., A. H. 1141
Engelhard Inc., Charles 1166
Eppley Laboratory, Inc. 1135

Fairchild Camera & Instrument Corp. 988
Falstrom Co. 952
Farris Engineering Corp. 1038
Farris Flexible Valve Corp. 1145
Fielden Instrument Division 973
Fischer & Porter Co. 1025
Fisher Governor Co. ..... Inside Front Cover
Flexonics Corporation 976
Fluid Controls Co., Inc. 1064
Foster Engineering Co. 992
Foxboro Company 960-961, 1065
Friez Instrument Div., Bendix 1061
Fulton-Sylphon Division 1007

Gaertner Scientific Corp. 1046
General Electric Company 995
Giannini & Co., Inc., G. M. 1003
G-M Laboratories, Inc. 1137
Gordon Co., Claud S. 992
Gotham Instruments, Div. of American Machine & Metals, Inc. 1019
Gow-Mac Instrument Co. 1073
Grayhill 1142
Green Instrument Co. 1157

Hagan Corporation 1016
Hagen Manufacturing Company, Inc. 1158
Hammel-Dahl Co. ..... Back Cover
Hankison Corporation 1152
Hathaway Instrument Co. 1072
Hays Corp. 986
Heise Bourdon Tube Co. 1072
Helicoid Gage Div. 1171
Helipot Corp. 1009
Hewlett-Packard Company 1001
Hexacon Electric Co. 1064
Hickok Electrical Instrument Co. 1148

Illinois Testing Laboratories, Inc. 1071
Imperial Brass Mfg. Co. 1011
Indiana Steel Products Co. 1065
Industrial Div., Minneapolis-Honeywell Regulator Co. 970, 994, 1062-1063, 1165
Industrial Engineering Corp. 1135
Industrial Pyrometer & Supply Co. 996
Industrol Corp. 1000
Ingersoll-Rand 1002
Instrument & Control Consultants 1164
Instruments, Inc. 1052
Instruments Publishing Co. 1018, 1122
International Rectifier Corporation 971

Johnson Engineering Company, Inc., Welton V. 1069

Karn Chemical Equipment Company 1056
Kemp Mfg. Co., C. M. 1067
Kendall Controls Corp. 1015
Kieley & Mueller, Inc. 950-951

Lambda Electronics Corporation 1156
Lapp Insulator Co., Inc. 1047
Leeds & Northrup Co. 984, 1020
Leland, Inc., G. H. 964
Leslie Co. 956
Levin & Son, Inc., Louis 1048
Lewis Egineering Co. 953
Librascope, Inc. 1050
Logistics Research Company 1036
Lord Manufacturing Co. 1040

Machinery Lloyd 1159
Magnetic Amplifiers, Inc. 1027
Manning, Maxwell & Moore, Inc. 966-967
Marsh Instrumet Co. 1144
Marshalltown Mfg. Co. 1135
Mercoid Corporation 1060
Meriam Instrument Co. 1163
Mico Instrument Co. 1169
Midwestern Geophysical Laboratory 977
Milton Roy Company 1005
Mine Safety Appliances Company 990
Minneapolis-Honeywell Regulator Co. 970, 994, 1062-1063, 1165
Mittelmann Electronics Corp. 1052
Moeller Instrument Co. 1073
Monsell, John R. 1058
Moore & Company, Samuel 1008
Moseley, Francis L. 1140

Nash Engineering Company 1121
New Hermes, Inc. 1174
Nife Incorporated 1130
Norcross Corporation 1138
North American Aviation, Inc. 964

Ohmart Corporation 1045

Pacific Universal Products Corporation 1174
Palmer Thermometers, Inc. 1067
Panellit, Inc. ..... 1176-Inside Back Cover
Panoramic Radio Products, Inc. 1139
Parker Appliance Company 1160, 1161
Penn Industrial Instrument Corp. 1064
Perkins & Son, Inc., B. F. 1132
Permutit Company 1133
Pittsburgh Lectrodryer Corporation 1012
Potter Aeronautical Co. 1042
Potter Instrument Company 1029
Powers Regulator Co. 968
Process Controls, Div. of Baird Associates 1044
Production Instrument Company 1140
Pyrometer Instrument Co. 1145

Radio Corporation of America 963
Rawson Electrical Instrument Co. 1058
Republic Flow Meters Co. 1153
Richards Co., Inc., Arklay S. 1138
Rochester Mfg. Co., Inc. 1059
Rockwell Co., W. S. 1172
Roller-Smith Corporation 1017
Rutishauser Corp. 1129

Sanborn Co. 1041
Schutte & Koerting Co. 959
Service Recorder Co. 1136
Servo Corporation of America 1059
Servomechanisms, Inc. 1051
Shore Instrument & Mfg. Co. 1060
Sola Electric Co. 987
Sound Apparatus Company 1066
Southwestern Industrial Electronics Co. 1155
Sprague Engineering & Sales Corp. 1136
Standard Electric Time Co. 1006
Statham Laboratories 1147
Steinen Mfg. Co., Wm. 978
Stitcht Co., Inc., Herman H. 1030
Streeter-Amet Co. 1067
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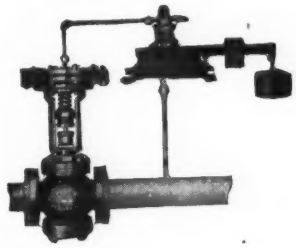

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